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Engineering News-Record

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March 8, 1928

New Levee Designs on the Mississippi
Cementing Oil Wells to Shut Out Groundwater
Sliding Forms Build Double Walls at High Speed
Details of Storm-Water Sewer Overflows
Building a Rolled-Fill Dam of Prewetted Earth
Temperature Control in Rooms for Concrete Study

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Ahead of Time

TOO often, large construction jobs are not completed until long after the scheduled date set when the work started. It is gratifying, therefore, to record the fact that one of the largest undertakings of recent years, the building of the dam and power house on the Susquehanna River at Conowingo, Md., is being completed months ahead of time. Two hydro-electric units began delivering power to Philadelphia on March 1, three months ahead of the time set for the first delivery of power, and all the units will be delivering power six months in advance of the date upon which it was expected they would be completed when the work was begun. This early completion is no chance happening. It is the result of systematic planning and co-ordinated efforts on the part of the engineers, contractors and manufacturers of equipment. Every day gained in putting the plant into operation meant many dollars saved for the Philadelphia Electric Company. All concerned with the construction of the dam and power house directed their energies to that end and the result is a record of which all may be proud.

New Earth Dam Practices

BOTH by its steep-sloped section and by the use of prewetted earth for its construction, the McKay irrigation dam of the Umatilla project is set apart from other earth dams. Few construction operations have become more nearly standardized than rolled-fill dam building. At most, slight differences in the slant and thickness of the rolled layers, a little more or less sprinkling, and more or fewer passages of the roller, distinguish one construction operation from another. It was therefore a decided departure from precedent when at the McKay dam the earth was wetted in the borrow pit before excavation instead of being spread dry and made damp by sprinkling on the embankment. The purpose of this procedure, described in this issue, was to insure a more homogeneously moist mixture than surface sprinkling of dry earth in 6- to 10-in. layers can be depended upon to give. By prewetting the ground before excavation the shoveling, loading, dumping and spreading constituted a veritable mixing process, so that the material put into the embankment not only was prewetted but also was premixed with water. The proof that this procedure gave good compaction exists in the almost negligible settlement of ½ in. which was recorded. The cost of 1c. a cubic yard for prewetting is about the average of the recorded costs of sprinkling. On the evidence of its performance and its cost in this single example, then, prewetting earth for rolled fill compares most favorably with the older sprinkling method. The steep upstream slope of 1 on 2 is an expression of confidence in an unusually good embankment material and in the filling methods employed, rewarded by half-a-million dollars' saving in cost. With the upstream paving and the provision of virtually three cutoff walls no instability of upstream slope which did not show up during construction is likely to be disclosed ultimately. Altogether the McKay dam construction presents a variation in rolled-fill earth dam practice that merits attention.

Building Codes and Sewers

REFUSAL of a building permit for an apartment house on the ground that the resulting addition to the population would overtax the existing sewers is noteworthy if not new, especially when the refusal is upheld by a supreme court as conservative as to zoning regulations as has been that body in New Jersey. Although the decision in the Montclair case, abstracted on p. 312 last week rests on the local building code, the basic principle seems applicable to zoning and that, too, even though the ruling was made to meet a temporary condition that will disappear when additional trunk sewer capacity already past the initial stage is provided. Whatever objections may be raised as to zoning for the sake of the amenities of life, a municipality certainly is justified in exerting control over such physical matters as the adequacy of water supply, fire protection and sewerage—not merely for a year or two while these facilities are being increased, but for a period of years. In other words, a city through use and height regulations may properly hold building construction to an orderly plan of city development, correlated with the various public works and services of the city. In jurisdictions where zoning is under the ban of courts still unwilling to recognize the constitutionality of zoning, the decision in the Montclair case points the way to a reasonable control of all the physical factors involved through the use of the building code.

Distrust in Utility Commissions

INTO the fine points of constitutional law involved in the refusal of the United States Senate to seat Mr. Smith of Illinois or the question as to how much money a senatorial aspirant and his supporters may ethically spend to insure election we have no reason to go in these columns. But in view of the importance of sound and honest regulation of our public utilities and the rapidly growing distrust of the people in utility commissions it seems fitting to say that the refusal of the Senate to seat a man in support of whose candidacy utility companies and high officials had contributed immense sums of money, although he was a public-utility commissioner and therefore in a peculiar position of trust as to utility affairs, is eminently salutary. This situation continues to be ignored by the dominant political forces of Illinois, now united in an attempt to force Mr. Smith on the Senate and the country by sending him to Washington

with a certificate of appointment to fill a vacancy. The interests of morality and good government demand that the Senate stand by its decision. If it does not, the confidence of the people in public-utility regulation will be still further weakened.

Day-Labor Cost Accounting

MINNEAPOLIS is prominent among cities that carry on public-works construction largely by day labor. With the new set-up for cost accounting described last week it now can fairly claim leadership in the perfection with which it determines the costs of its day-labor work. This is a notable attainment. Not many cities can display cost records of their day-labor construction which an expert accountant would indorse as comprehending all the costs that entered into the work. As much as any one thing, perhaps, this lack of cost records accounts for the prolonged dispute that has been carried on between contractors and those public bodies that have chosen day-labor construction of public works. The deciding factor of cost has been not only undetermined but indeterminate. In the new cost accounting system which the Minnesota metropolis has instituted provision is made to include not only the directly assignable costs but also a proportionate part of the cost of general city administration, equipment depreciation, materials purchasing, etc. In brief, overhead expenses are assembled and apportioned in all the inclusiveness with which they have to be charged up in private business. This point is emphasized particularly because always the claim has been made by contractors that neglect of overhead and rental costs furnished the only peg on which day-labor construction could hang any evidence of the economy of the method. The state law in conformity with which the new accounting system has been planned and put into operation owes its existence to constructive and energetic association work by contractors. This law gives recognition to overhead, depreciation and rental. As a means of day-labor construction practices we suspect that it will be far more influential than any direct action taken to forbid day-labor work.

Changing Habits

SOME surprising facts are disclosed by a trade census being conducted in a number of representative cities by the domestic distribution department of the Chamber of Commerce of the United States. Women's hosiery is being sold in grocery stores, tobacco in bakeries, hardware in drygoods stores, radio sets in gasoline filling stations, hats in shoe stores and shoes in hat stores. Men's clothing can be bought in stores that sell furniture, leather goods, shoes, cigars, groceries, hardware and jewelry, as well as in department stores and restaurants. These are the facts with the sensational news appeal. The survey is also determining as between cities such basic information as the relative number of retail and wholesale outlets, the sales of various standard articles, the importance of the chain store, the percentage of sales volume done by the different types of stores and the salaries and wages paid. This census has a far wider significance than its apparent and immediate one to wholesale grocers and cloak and suit manufacturers, for it illustrates a development that is under way in every field, that of civil engineering construction included. Habits are changing. Methods of merchandising, and for that matter of construction technique, are in a constant state of metamorphosis. Too often these changes are dismissed with scarcely a thought until something such as this survey gives them prominence. The findings serve to bring to consciousness one of the changing habits in industry, that of placing distribution of products on the same level of importance as mass production. It behooves everyone to acquaint himself with the significance of this change, and consciously to look about and evaluate other changing habits and methods that are likely to affect the progress of his industry.

No Progress

THREE months have passed since Congress took up Mississippi River flood control, but no decision to build protective works has yet been reached. The high-water period is close at hand, and another one is but a short working season away. For this spring nothing more can be done, and the emergency repair of the levees that was begun after the 1927 calamity must needs be our whole dependence. But what of the work that should now begin to provide against next year's flood? Is it to be crippled and made unpromising of success by continued procrastination?

There are studies and plans to be made before work can begin, but these must wait until Congress makes up its mind on the system of administration and on the magnitude of the operations to be authorized. No approach to devising an organizational system can yet be perceived, and even the basic policies that will control the planning have not come to discussion. The situation is becoming more than disquieting. Our system of legislation is making a sorry showing in the one predominantly urgent problem that confronts it.

Congress, of necessity, bears the present blame for this serious condition, since it alone has the responsibility for initiating action. But while its responsibility can in no way be minimized, the share of blame resting on the executive department of the government is too weighty to be overlooked. A plan and an estimate worked out by that department were presented for decision by Congress—to be taken or left, for no alternative was submitted. But they are such as would inevitably be rejected by any authority charged with deciding on their adoption. The estimate of cost confessedly includes only a fraction of the expense, and even as to the admitted fraction it is under gravest suspicion of inadequacy. Congress and others have come to apprehend that the estimated figure of less than three hundred millions may be hopelessly exceeded, and that expenditures may well pass a billion. Were Congress to adopt the plan proposed it would be in the position of signing a blank check in the name of the nation, with hardly a limit to its possible face.

Moreover, with cost altogether disregarded, there remain fundamental doubts as to the technical soundness and efficacy of the plans—doubts clearly expressed by many engineers outside government circles, and clearly enough realized by members of Congress. The New Madrid floodway, shallow diversion channels a dozen miles wide the sufficiency of which was merely guessed at, reliance on haphazard crevasse formation to relieve an overburdened channel, levees flowing within a foot of the top in a great emergency, such elements of the plan utterly failed to engage that confidence vital to the undertaking of the great enterprise. That this should be the

case is a serious reflection indeed on the governmental authorities responsible.

Confronted with these conditions, Congress must nevertheless act, if relief from the threat of disastrous flood is to be provided reasonably soon. If it cannot act on the plan before it, then, obviously, it must create an organization competent to work out a dependable plan, with full and correct costs. Such information is indispensably necessary before the scope of the enterprise is capable of definition. At the same time actual work in the field will have to be started, even before the estimates are at hand.

The requirements are severe, but they can be met. What time has been lost through delay can yet be retrieved, with prompt action. There is no lack of ability and energy in the engineering profession to carry out the task. To enlist those abilities, however, Congress must act with vision and energy.

Outdoor Type Hydro-Electric Units

THE DESIGN of a power house built in the West not long ago was rearranged prior to construction to put outdoors certain electrical apparatus for which space had originally been provided within the power house. By making this change the first cost of the installation was decreased $80,000 with no loss of efficiency or dependability. This instance suggests that the same idea might be carried farther now that the competition between steam and hydro power has become keener than ever before.

Notable advances have been made in developing outdoor type transformers, switching equipment and other electrical apparatus, but there has been very little corresponding progress in the design of the main generating units themselves. As an argument against putting the main units outside, even if they were designed for such service, it has been pointed out that it is necessary to have a crane over them and that the supports for the crane at the same time serve as part of the housing structure. It is true that shelter must be provided for operators, for various control mechanisms and for delicate indicating and recording instruments, hence some sort of power house will always be required. However, the present-day plan of erecting an expensive structure over large hydraulic turbines certainly could be modified in some cases. Overhead cranes designed for outdoor service are in common use, and it should be feasible to erect supports for such cranes that would be less expensive than the walls of a power house. Remote control devices have now come into use so extensively that it is unnecessary for the operator to be close to the unit itself. A large percentage of modern units are of the vertical type, for which much of the inspection and other routine work incidental to operation has to be done in the sheltered space below the floor level. All things considered, therefore, it is not a far cry from the type of equipment now used to an outdoor type in which the initial cost for power house structure would be considerably less.

Putting the main units outdoors would make it unnecessary to crowd them closely together in the manner dictated by economy of power house design when they are housed. As has been found to be the case in the design of transformer and switching equipment, it is quite possible that generating units when built for outdoor service will be more accessible and easier to handle when changes are necessary.

Study and Knowledge

THERE is an old saying to the effect that when we become conscious of ignorance we are at the beginning of knowledge. Judged by this saying—in which there is much obvious truth—the concrete art appears to be in a most promising state, for its principal meeting of the year, held last week at Philadelphia, showed a live appreciation of the shortcomings of what is known today. It was clear from the meeting that a remarkable amount of study in concrete is in progress, and that important results continue to flow from this study, but dissatisfaction with what has already been learned was even more strikingly evident. This dissatisfaction is the forerunner of improvement.

In a subject so many-sided and elusive as that of concrete, it is natural that views should diverge and dwell on many points rather than center obviously on the main problem. Yet it is easily possible to recognize that the real concern, the essential point of ignorance, relates to concrete quality. The call of the day is for better concrete. Nathan C. Johnson, who dealt forcefully with this theme, was hopeful enough to predict that if we will but make the demand insistent, and undertake to search out the secrets of good concrete by truly scientific methods, an early success is assured. And many other papers and discussions at the meeting manifested a willingness—even an eagerness—to recognize that not all concrete is good. The spirit of the convention broadly was that of confident striving for better concrete, better not only in the laboratory sample but also in the field product.

There is a prodigious amount of research and study in progress now, dealing with individual properties of concrete, each of great importance, among them volume change, tightness and plastic flow. Taken together with the great amount of concrete research done in the past, it seems to justify the proud assertion of one of the speakers that concrete has been the subject of more engineering study and research than any other building material. But there is much more study still to come. The insistent demand for better concrete will not be satisfied by either slogans or partial solution. It calls for a more penetrating study of the nature of that protean composite around which a large part of the modern constructional arts have grouped themselves.

Meanwhile it is of unusual interest to observe the live attention given to the subject of workability. It was the theme of the most active session at the Philadelphia convention. Primarily a practical problem, since an intimately incorporated and smoothly handled mixture is necessary for good placing, it may yet prove to be related quite directly to the final result—the quality of the concrete. But for the time being we are in difficulty because there is no recognized method of measuring workability, and this in turn means, of course, that we do not know exactly what it is. It is not the same as mere softness; of that we are convinced. But beyond this one point we are uncertain.

This very uncertainty and the active study and work to which it gives rise promise an early clarification of views and the development of real knowledge on workability. Possibly when we have this knowledge, we shall find that workable concrete has some fairly direct relation to good concrete—that is, permanent concrete. Certain it is that the seeking for workability will help us along the road to uniform concrete, which is more than half the answer to the problem of good concrete.

Building a Rolled-Fill Dam of Prewetted Earth

McKay Dam 165 Ft. High for Umatilla Irrigation Works Takes Advantage of Stable Material to Cut Down Costs by Steep Slopes and Concrete Paving

By Ralph Lowry
Resident Engineer, U. S. Reclamation Bureau, Augusta, Mont.

With Exceptional Experience in earth dam construction by all processes, the engineers of the U. S. Reclamation Bureau have undertaken successfully, on the Umatilla project in Oregon, to build one of their highest earth structures to unusual section by using a local gravel and loam soil prewetted to secure exceptional compaction and cementation when rolled into fill. With this material a wetted slope of 1 on 1¼ and a dry face of 1 on 2 have been secured. Compared with the usual 1 on 3 upstream slope, this section has afforded a saving of half a million dollars. The building and paving of the fill are primarily described in this article. Incidentally the overfilling of the upstream slope to permit trimming to solid fill for the pavement foundation is deserving of attention. There is also interest in the multiple cutoff walls; with the toe wall of the paving there are three walls. Comparison is also suggested with the semi-hydraulic fill method adopted by the reclamation engineers at the Guernsey dam described in *Engineering News-Record*, Feb. 16, 1928, p. 264. —Editor.

A NOTEWORTHY EXAMPLE of a high gravel-fill dam having the upstream face covered by a continuous slab of reinforced-concrete paving is the McKay dam recently completed by the U. S. Bureau of Reclamation. The dam is on McKay Creek, a branch of the Umatilla River, about 7 miles south of Pendleton, Ore., and is a part of the Umatilla federal irrigation project. It creates a reservoir 4 miles long by a mile wide, with a storage capacity of 73,000 acre-ft. to supplement the river flow. Construction was started in July, 1923, and completed in December, 1926, all work being performed by government forces. There is a combined diversion and outlet tunnel through the right abutment and an open concrete-lined spillway around the right end. The embankment, containing 2,287,000 cu.yd., has a top length of 2,700 ft., a maximum height above the creek channel of 165 ft., a 1 on 2 downstream slope and the unusual upstream slope of 1 on 1¼. The completed dam is shown in Fig. 1, and its general design in Figs. 2 and 3.

To determine the most economic type of dam, preliminary designs were prepared for nine different types, with estimated costs as follows: (1 to 4) Four designs of gravel fill with reinforced-concrete face, but with different slopes, $2,499,000 to $2,724,000; (5) gravel fill with puddle core, $2,981,000; (6) gravel fill with concrete core wall, $3,208,000; (7) multiple-arch with gravel fill for end of south abutment, $2,866,000; (8) rock fill with reinforced-concrete face, $4,915,000. In the ninth and adopted design, advantage was taken of the unusually stable embankment material available to give a somewhat steep slope, resulting in a saving of about $500,000 as compared with the 1 on 3 upstream slope commonly used for earth-fill dams.

Embankment Foundation—Lava rock is exposed at the north abutment, and is overlain by soil and gravel to a depth of 1 to 12 ft. across the valley floor. At the south abutment this rock is covered with soil and cemented gravel from a few feet in depth at the valley floor to an undetermined depth at the end of the dam. All top soil was stripped down to compact gravel, cemented gravel or solid rock, and was deposited above the upstream toe, where it was later spread in the form of an earth blanket. For removing this 160,000 cu.yd. of soil, four-horse fresno scrapers were used for short haul, and dump wagons loaded by shovel or draglines for the longer hauls.

A loose-rock fill along the downstream toe varies in height from 20 ft. at maximum height of dam to 5 ft. at each end. A 12-in. blanket of loose rock was also placed under the main embankment over the downstream third of the foundation where solid rock was exposed. Two concrete cutoff walls, founded on rock and extending 4 ft. up into the embankment, were placed across the valley floor and up the north abutment, where the rock was either exposed or within 3 ft. of the foundation surface. One of these walls was placed along the longitudinal axis of the dam and the other midway between the axis and the upstream toe. In a trench 3 to 20 ft. deep along the entire length of this toe, there is a third cutoff wall having a minimum thickness of 2½ ft. and forming the toe wall of the slope paving. The bottom of the trench was in solid rock except at the south end, where 300 ft. was in impervious cemented gravel.

In the rock bottom of the trench, holes for grouting were drilled 2½ to 10 ft. c. to c., spacings under 10 ft. being determined by progressively grouting the holes as drilled. Their maximum depth was 45 ft. at the maximum height of dam, decreasing uniformly to a minimum of 20

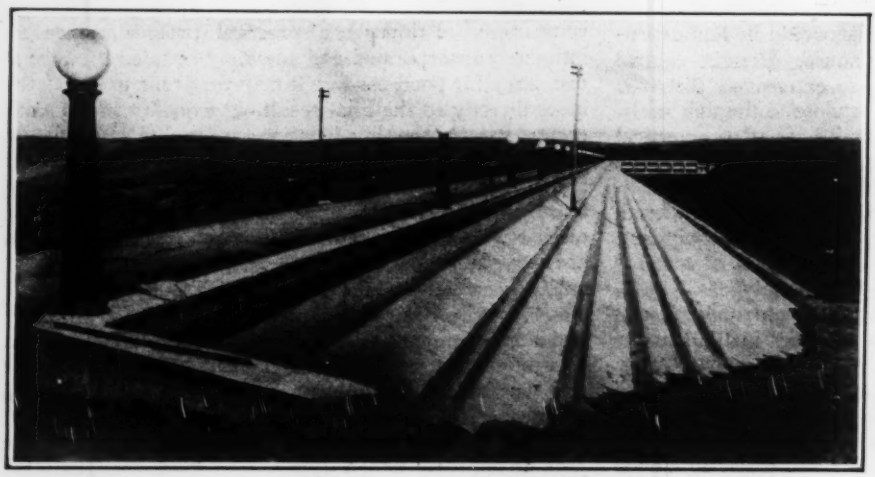


FIG. 1—McKAY DAM WITH PAVED SLOPE STEPPED TO BREAK WAVES

ft. An air-driven water-fed drill, mounted in a small derrick frame, put in the 11,200 ft. of grout holes. Cement grout was forced in to refusal, with air pressure not exceeding 100 lb.

Owing to the number of steels required for a 45-ft. hole, the variation in bit gage between successive drill steels was necessarily small, and using a set of steels that had previously been sharpened with a uniform gage increment usually resulted in the gage of one bit wearing off so that the following steel could not be put down to the bottom of the hole, but would wedge along the sides. This difficulty was largely overcome by sharpening the following steel to the reduced bit gage of the worn drill steel just taken from the hole.

Embankment Construction—Material in the main embankment consists of a well-graded gravel containing a varying amount of earth and sand, with a small percentage of clay. There was usually a sufficient percentage of fines completely to fill the voids in the gravel. When a deficiency in fines occurred, at short and infrequent periods, care was taken to prevent the formation of a porous layer extending through the fill. Material that contained a large percentage of soil was wasted.

Embankment material obtained about 1½ miles upstream was excavated by two electrically operated shovels with 2½-yd. dippers and was hauled in 4-yd. side-dump cars by 18- and 20-ton oil-burning locomotives. The shovel cuts were 6 to 10 ft. deep. A special feature was the wetting of the material before excavation, by means of pumped water applied by the irrigation method ahead of the shovels. The quantity of water was varied to suit the material, so that when it reached the dam it had the proper consistency for maximum compacting.

Difficulty with this material sticking in the cars when dumped, especially when it contained a relatively large percentage of soil, was partly overcome by installing sheet-steel bottoms in the cars. The convenience, economy and uniformity of moisture content that resulted from wetting the material in the borrow pits more than compensated for the increased cost of handling due to material sticking in the cars. The material as excavated had a consistency similar to a dry-mixed concrete.

At the dam, Fig. 4, material was dumped in longitudinal rows and spread by horse-drawn grading machines, the layers not exceeding 8 in. in depth. Each layer was extended at least 2 ft. beyond the neat line of the upstream slope and compacted by rolling with 11-ton, oil-burning traction engines, one rear wheel of the engine passing over each square foot of surface at least four times. For a width of 15 ft. adjacent to the upstream slope each layer received at least six passes of the roller.

This placing and compacting of material beyond the upstream slope was done to insure a stable foundation for the concrete face. After each successive 20-ft. lift, the excess material on the upstream slope was stripped by dragline excavators and the material replaced in the body of the embankment. All boulders more than 8 in. in diameter were either broken up or removed and placed in the downstream toe drain. No placing was done when either the material or the embankment was frozen.

Usually two lines of tracks with 45-lb. rails on 7x7-in. ties were operated on the fill, one covering the down-

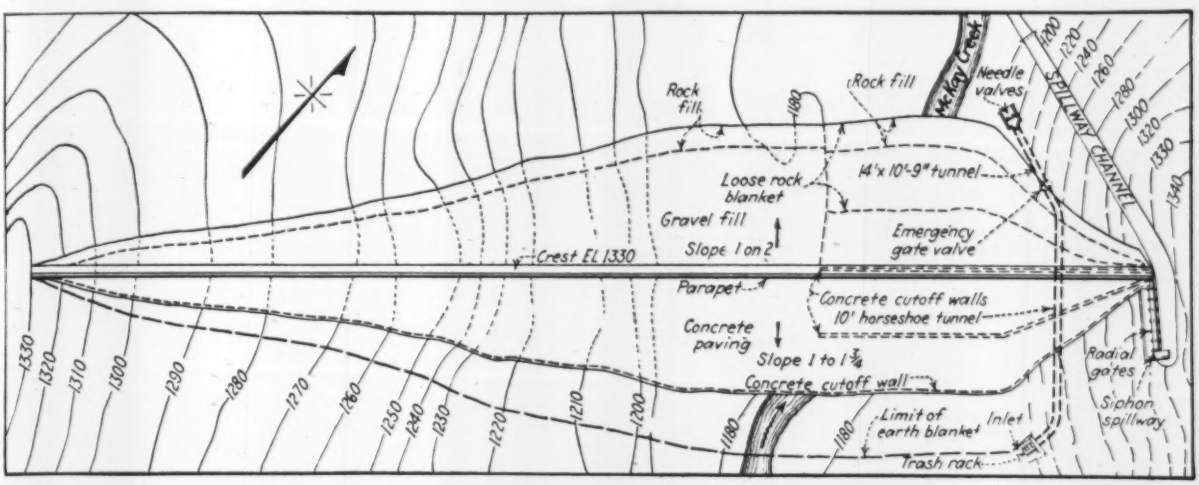


FIG. 2—GENERAL PLAN OF McKAY DAM AND OUTLET WORKS, UMATILLA PROJECT, OREGON

stream half and the other the upstream half, both being maintained parallel to the longitudinal axis. They were shifted back and forth across the embankment by horses. In addition to the electric shovels, there were eleven locomotives, 120 dump cars, five traction engines, a ½-yd. dragline and three graders. A shop and a warehouse were maintained for repairs to equipment.

Placing the gravel fill extended over 23 months, February, 1924, to December, 1925. It was carried on continuously, except for about one month during the winter of 1924-25. The maximum quantity placed in any one month was 166,000 cu.yd., and the maximum daily run was 8,000 cu.yd., each with two eight-hour shifts. The field cost of material in place was 44c. per cubic yard, itemized as follows: Wetting, 1c.; loading, 7c.; hauling, 13c.; dumping and spreading, 9c.; compacting, 2c.; track maintenance, 3c.; plant and equipment, 9c.

After the embankment was completed, points were established in the crown and their elevations were observed periodically until July, 1926. The maximum settlement was less than ½ in.

Concrete Paving—The upstream face is protected by a reinforced-concrete slab, 8 in. thick at the top of the embankment and increasing to 12½ in. at the bottom of the highest section, the rate of increase being 1 in. to every 70 ft. down the slope. At the top the slab is connected to a cantilever type of concrete parapet wall 6½ ft. high, which extends 2½ ft. above the gravel fill. The bottom of the slab is keyed into the concrete cutoff wall

along the toe. The reinforcement is continuous and consists of ¾-in. round steel bars at the center of the slab and spaced 18 in. c. to c. both ways. Owing to the slope of 1 on 1¾, careful work was required to insure that the concrete would be dense and durable and as nearly watertight as possible. Beginning at the bottom, it was placed in four main horizontal sections, each measuring about 80 ft. up the slope and extending from one abutment to the other.

A section of the face was first trimmed by hand, removing several inches of material which had been left to prevent weathering of the surface below the grade for the concrete face. Then the reinforcing steel was placed in position and supported by improvised chairs bent from pieces of reinforcing steel. Screed boards, 2x6 in. at the bottom of the embankment and tapering to 2x4 in. which improved its workability and facilitated finishing.

Near the top of the slab and integral with it were formed five steps 12 in. high, 6 ft. apart up the slope and extending the entire length of the embankment, in order to break up wave action and prevent the water from washing up the face and breaking over the crest of the gravel fill. These steps are shown in Figs. 1 and 3. The face slab contains 17,250 cu.yd. of concrete, placed at a cost of $14.90 per cubic yard.

Spillway—The spillway channel cut into the rock around the north end of the dam discharges into the creek about 300 ft. from the toe. It has a bottom width of 16 ft. and side slopes of 2 on 1. As the rock in the upper portion of the channel was found of excellent quality, the concrete side lining of this portion was omitted. A system of underdrains was provided for

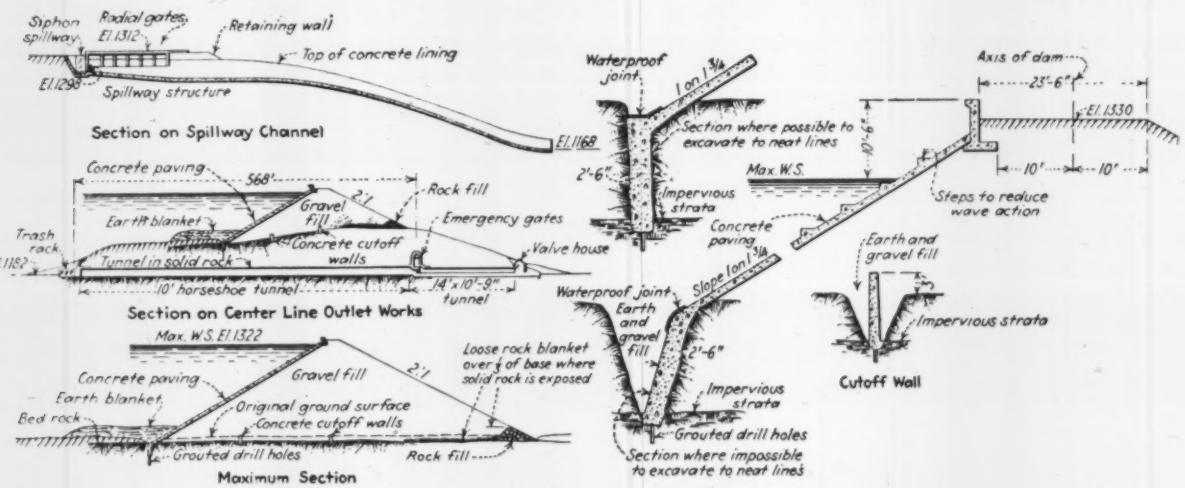


FIG. 3—SECTIONS OF McKAY DAM EMBANKMENT AND SLOPE PAVING

at the top, were fastened to and on top of the reinforcing steel at 12 ft. c. to c. This work is shown in Fig. 5.

From the ½-yd. mixing plant on the south abutment at the upstream toe a level track was built along the embankment face, just above the section of slab being placed. Concrete was hauled in cars drawn by gasoline engines and dumped into a metal-lined wooden chute, built in 6-ft. sections, which extended down the slope in the center of the panel. As the concrete was brought up the slope, the chute sections were removed.

A screed, or finishing board, 2x6 in., was worked back and forth up the slope on top of the screed boards (Fig. 5) and the concrete was at once finished by hand with wooden trowels, giving a dense and uniform mortar surface. Where necessary for this surface, a small amount of sand-cement mortar was added to the plastic concrete surface while troweling. Alternate panels were placed during two days, then the screed boards were removed and the intervening panels were concreted. The concrete was sprinkled for seven to ten days. It was necessary not only to have the concrete wet enough to chute down the slope but also to have it sufficiently dry to remain on the slope without slipping. This required a consistency measured by 1½- to 2-in. slump. The reinforcing steel aided in holding the concrete in place. Concrete having a compressive strength of 2,000 lb. per square inch at 28 days was specified, and test cylinders were taken at frequent intervals. The concrete in the upper portion of the slab contained diatomaceous earth, both the sides and the bottom of the lining. The reinforcement was anchored by 1-in. square bars 10 ft. c. to c. both ways, grouted 4 ft. into the rock.

Flow from the reservoir into the spillway is controlled by six radial gates 20x10 ft. and a two-barrel siphon spillway. Each siphon has a throat section 8½ ft. wide by 2½ ft. high, with the crest at the same elevation as the top of the gates when closed. These gates are individually motor-operated by hoists located directly overhead on a reinforced-concrete deck. Two of the gates are controlled automatically by float switches in wells in the adjacent piers. The spillway is designed to pass 10,000 sec.-ft. through the gates with 10 ft. of water on the gate sills. The siphon units will pass an additional 1,000 sec.-ft. The maximum recorded flood of McKay Creek at this site is 3,700 sec.-ft.

The excavation of the channel involved 32,000 cu.yd. of solid rock, which was drilled with jackhammers and then shot. Power-operated drag buckets moved the loose rock to the lower end of the channel, where it was loaded by gravity into 4-yd. dump cars and placed in the downstream toe of the fill.

Outlet Works—The outlet tunnel, 705 ft. long, is located in the rock under the north abutment. Its upstream portion for 550 ft. is of horseshoe section equivalent to 10 ft. in diameter, while the downstream portion has a semi-circular arch, a flat curved invert and vertical sides. The tunnel is lined with 12 in. of concrete. Water from the reservoir passes into the tunnel through

FIG. 4—CAR-DUMPED MATERIAL SPREAD AND ROLLED IN LAYERS

trash racks consisting of §x6-in. bars, 6 in. c. to c. It then passes through the tunnel to two hydraulically operated emergency slide gates, 4x4 ft. As that part of the tunnel between the gates and trash racks is under reservoir pressure, the rock was grouted through pipes embedded in the concrete lining.

A concrete-lined, dome-shaped chamber, in which the controls for operating the emergency gates are located, was constructed in the solid rock above the gates. These gates connect with twin 54-in. riveted steel pipes, which carry the water through the remaining 155 ft. of tunnel to two 48-in. balanced needle valves discharging into the open air. The valves and their mechanisms are housed in a reinforced-concrete building at the outlet portal. Access to the emergency gate-operating chamber is obtained by a passageway through the valve house and the downstream portion of the outlet tunnel. The quantity of water released is controlled by the needle valves, the purpose of the emergency gates being to stop the flow for repairs or inspection of the valves.

The tunnel was driven in three months, working from both portals. Some overbreakage occurred, but no timbering was required, as the rock was sound and solid. The excavated rock was placed in the downstream toe drains of the dam. During the construction of the dam, the creek was diverted through the tunnel. As this creek is practically dry for several months in the summer and the maximum flow during construction did not exceed a total of 1,200 sec.-ft., it gave little trouble at any time.

Costs—Quantities, unit costs and total costs are given in the accompanying table. The dam was constructed for $385,000 less than the estimated cost.

Operation—To avoid subjecting the new fill to an unnecessary load, the water during the past season was not permitted to rise above El. 1,293, or 29 ft. below full reservoir level. This provided ample storage for irrigation. The operation of the emergency gates and the needle valves has been entirely satisfactory.

Organization—A large proportion of the labor employed was secured locally, and the maximum force at any one time was about 300 men. A considerable number of the men resided in Pendleton, 7 miles distant. A well-built camp, with buildings for 150 single men and ten families, was provided with both water and sewer system and electricity. Its water supply was pumped from a shallow well and chlorinated at the pump.

All activities of the U. S. Bureau of Reclamation are under the direction of Dr. Elwood Mead, commissioner, at Washington, D. C. The designs for the dam were prepared in and the construction was directed from the Denver office of the bureau, where R. F. Walter is chief engineer and J. L. Savage is chief designing engineer. R. M. Connor was engineer in charge of the construction forces and the writer was resident manager.

FINAL COST OF McKAY RESERVOIR, OREGON

Item	Quantity	Unit Cost	Total Cost
Examination and surveys	.....	.....	$17,248.02
Right-of-way and lands	.....	.....	176,133.25
Clearing	.....	.....	5,935.90
Care and diversion of river	.....	.....	4,030.30
Excavation—Stripping for embank. Cl. 1, cu.yd.	160,155	$0.36	57,669.77
Dam and cutoff trench, cu.yd.	10,176	2.38	24,289.87
Spillway structure, cu.yd.	4,495	1.61	7,259.97
Spillway channel, cu.yd.	32,234	2.24	72,332.90
Outlet (open cut), cu.yd.	2,037	3.35	6,832.12
Outlet tunnel, cu.yd.	4,186	6.42	26,886.05
Embankment, cu.yd.	2,287,010	0.44	1,008,539.03
Toe drain for embankment (loose rock), cu.yd.	51,198	0.59	30,061.90
Structure drainage, spillway	.....	.....	2,052.55
Grouting (outlet work)	.....	.....	2,698.67
(upstream cutoff in dam), lin.ft.	11,201	1.43	16,034.92
Concrete—Dam (reinforced in cutoff), cu.yd.	1,656.5	12.55	20,787.78
Paving (reinforced), cu.yd.	17,251.4	14.90	256,735.04
Dam (reinforced), cu.yd.	1,470.2	18.10	26,634.33
Spillway (reinforced), cu.yd.	2,867.9	17.50	50,149.58
Outlet works and valve house (reinforced), cu.yd.	568	25.55	14,521.50
Outlet tunnel lining, cu.yd.	1,757	16.85	29,603.75
Riprap, spillway, cu.yd.	432	5.48	2,385.60
Backfill around structures	.....	.....	5,324.49
Radial gates, six 20x10 ft., lb.	88,665	0.20	17,526.99
High-pressure emergency gates, two 4x4 ft., lb.	95,920	0.19	18,810.49
Balanced needle valves, two 48-in., lb.	44,055	0.23	10,000.00
Riveted steel outlet pipe, 54-in., lb.	89,375	0.12	10,860.66
Gates	.....	.....	730.58
Structural steel	.....	.....	1,377.58
Hand railing—spillway	.....	.....	469.99
Lighting system	.....	.....	2,941.38
Electric installation—outlet works	.....	.....	2,365.11
Permanent improvements (gate tender's cottage)	.....	.....	3,097.19
Camp maintenance	.....	.....	34,399.20
Engineering and inspection	.....	.....	49,955.27
Superintendence and accounts	.....	.....	43,353.41
Total field cost			$2,060,035.14
General expense			55,161.98
Grand total actual cost			$2,115,197.12
Estimated cost			$2,500,000.00

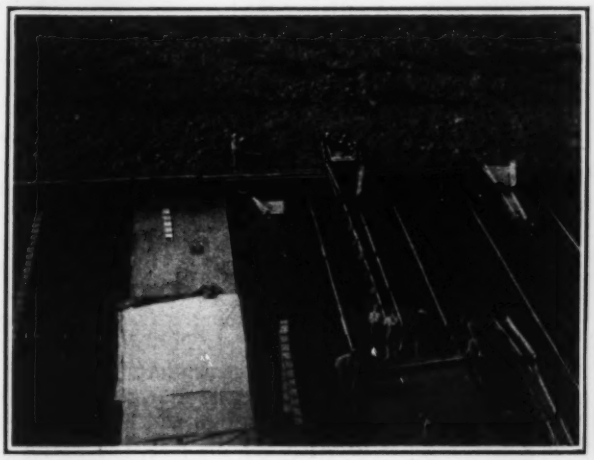


FIG. 5—SLOPE PAVED IN HORIZONTAL STRIPS 89 FT. WIDE ON SLOPE

Red Bank Iron-Removal Plant

In an article describing the iron-removal plant for the water-works of Red Bank, N. J., which appeared in our issue of Jan. 19, 1928, p. 114, the name of the general contractor was omitted. The plant was built by the firm of Maggi & Schoonover, Red Bank, N. J.

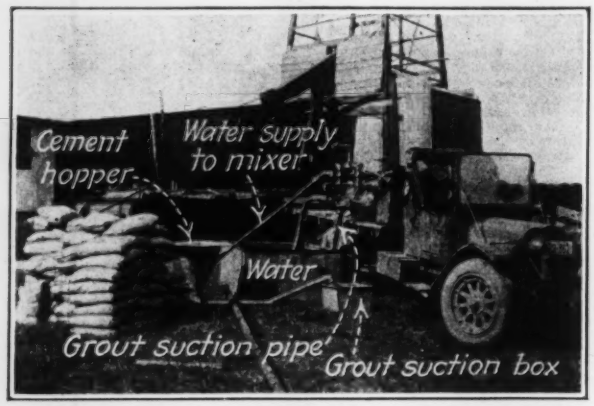
Cementing Oil Wells to Shut Out Ground Water

Methods and Equipment Used to Combat Water Intrusion and Some Observations Looking to Better Results

By John F. Hough
Structural and Technical Bureau,
Portland Cement Association

DEALING with water intrusion in oil wells is considered a major problem by oil-production engineers. The process known as cementing oil wells has become the outstanding method of excluding ground water, and this article is written to review the procedure now in use and to put on record some results observed by the author after considerable research in the fields of Oklahoma and Texas.

Old Methods of Shutting Off Water—In the early days top water was shut off by reducing the diameter of the hole at a given point and allowing the weight of the string of casing to rest upon the resulting shoulder. The



EQUIPMENT USED IN MIXING GROUT FOR CEMENTING OIL WELLS
In this illustration the cement grout suction pipe is in the water tank because the well is being flushed with clear water.

dead weight of the casing was enough to form a tight seal temporarily, but water would eventually saturate the formation and wash a channel through. In that case dried grain such as wheat or barley and sometimes beans was poured down the outside of the casing. Upon swelling, these substances would many times conquer the infiltrating water.

From this developed the first packer, the seed bag. Then followed a heavy rubber ring called the buttonhole packer, which would expand to make a tight seal when the weight of the casing was placed upon it. However, rubber, being soluble in petroleum and subject to hardening under water or in the air, soon lost its value as a packing material. Packers of hemp or other fibrous material were developed and employed with varying degrees of success.

Portland Cement—With the inauguration of the use of portland cement for combating water problems many engineers turned their attention to the development of a cementing process. This process now involves special devices for mixing and placing cement grout in wells, and individuals and corporations, exercising the rights of patent, have developed many successful methods that are held available in nearly all petroleum production areas.

In all the methods cement is used in the form of a neat grout. The consistency of the grout as used is governed by the ability of the equipment to handle it or by physical conditions within the well, but in the majority of cases cement slurry mixed in the proportions of $4\frac{1}{2}$ gal. of water per sack of cement can be handled and placed. Briefly, all the methods involve the placing of the cement grout between the casing to be cemented and the wall of the hole, and at or near the bottom of the hole. The quantity of cement used on a single job varies from twenty to 600 sacks, with an average of perhaps 200. In extreme cases, where caving formations were encountered, as many as 7,500 sacks of cement have been used in a single well. After being placed, the cement grout is allowed to harden for at least three days and often for ten days before operations in the well are resumed.

Dump Bailer Cementing Process—In cementing a string of casing by this method the cement grout is placed in the bottom of the hole by means of a bottom-dump bailer. Several runs may be necessary to deposit the entire quantity of grout to be used. After this is done the casing is raised from the bottom until the shoe is well above the top of the column of cement. The casing is then filled with water, closed at the top and lowered slowly to the bottom of the hole. There being no outlet at the top of the casing for the water, the cement cannot enter at the bottom, so it takes the only open course and rises outside the casing, filling the space between the casing and the walls of the hole. In this method when a large quantity of grout is used considerable time is involved in the mixing and placing and there is some chance of the cement taking its initial set before the casing is finally lowered. If the well is making water from below or is producing gas, this process cannot be used successfully because the agitation caused by the filtering of the water or gas will have a detrimental effect on the grout. Another difficulty arises when, on account of leaks, the casing cannot be filled with water.

Several types of plugs have been designed to be used in cases where it is impossible to raise the water level in the well. These plugs are so constructed that they may be moved in either direction within the casing until they are in the location desired by the driller. When set in place at the bottom of the casing before it is lowered into the dumped cement grout, the plugs will accomplish the same purpose as the tight head and column of water previously described. These plugs are made of cast iron and can easily be drilled up after the grout has hardened.

Tubing Method of Cementing—The tubing method of cementing involves the insertion of a 2-in. pipe down the center of the casing, extending to within a few feet of the shoe, through which the cement grout may be pumped and placed at the bottom of the well. The tubing must be packed off at some point to seal the annular space between the tubing and the casing, which, when filled with water, will prevent the grout from going up the inside of the casing and will force it up between the casing and the wall of the hole. For mechanical convenience it is customary to put the packing device at the top of the casing where the tubing goes through the bradenhead.

In employing this method of cementing, the driller is first sure of circulation before he starts placing the cement. After circulation is assured and has continued for a few minutes to wash out the hole, the casing is pulled up several feet and the grout is pumped down the tubing. When it has all been run, the tubing is raised

a few feet, flushed with water and then sealed, after which the casing is lowered. The grout remaining in the bottom of the casing is easily drilled out after it has hardened. The pressure sealed within the casing may become dissipated through defective fittings during the interval in which the grout is hardening, and it may be necessary for the drilling operator to maintain with his pumps a hydraulic pressure of 50 lb. or more until the grout has sufficiently hardened.

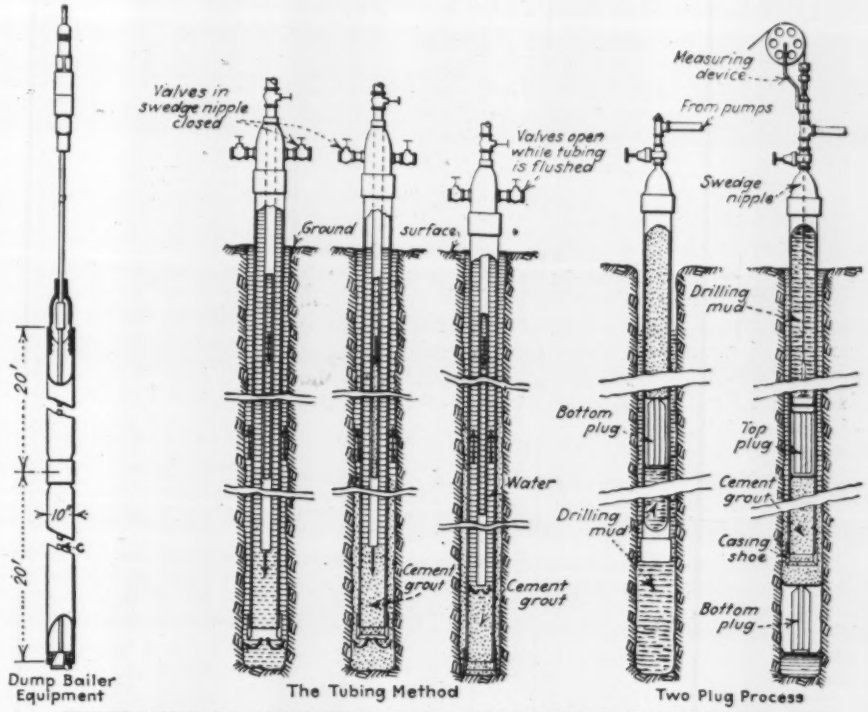
Cementing With Drilling Mud—Oil wells drilled with a rotary tool are frequently taken approximately their full depth before the water string or casing is run. The condition of the earth formation makes this possible. Rotary tools are lubricated with drilling mud, which is kept in constant circulation down the inside of the drill stem, out through openings in the bit and back up the outside of the stem to overflow into the mud pit at the base of the derrick. This circulation flushes the drill cuttings out of the hole. Mud fluid may vary from practically clear water with a specific gravity of 1 to a pasty mass of mud with a gravity of about 1.45. Under the rotary action of the drilling tools the mud closely packs against the sides of the hole, often causing a temporary water shut-off in strata of low static pressures, preventing caves and otherwise giving the walls of the hole sufficient strength to allow nearly full depth of the well to be attained before the water string is run.

Two-Plug Cementing Process—In the two-plug or Halliburton process of cementing, specially constructed plugs are used to separate the column of cement grout from the drilling mud or water in its downward passage through the casing. These plugs are constructed of light wood with as few nails and screws as possible, to permit their being easily drilled up after the cementing operation. Rubber washers are used at both ends of the plugs to prevent the passage of mud fluid, cement grout or water. The top cementing plug is equipped with a cupped leather washer to establish a tight fit with the casing.

After completely flushing the hole, with the casing held a few feet from the bottom, a bottom cementing plug is inserted at the top of the casing, a swedge nipple with the necessary valves and fittings is screwed on and connection is made with the cementing pumps. The mixed grout is pumped into the casing, forcing the bottom plug down ahead of it, which in turn continues the circulation of the mud fluid. As the plug travels down ahead of the column of grout it effectively seals off the casing and keeps the cement grout and mud fluid separated. After the lower end of the column of grout reaches the bottom of the casing, the plug passes out, and the cement starts upward around the outside of the pipe. Owing to its lighter weight, the mud fluid between the casing and the wall of the hole is forced ahead of the cement without any separating barrier.

As soon as the predetermined amount of grout has been pumped into the casing, the swedge nipple or casing head is removed and the top plug inserted. Under ordinary circumstances the column of cement grout in the casing is only partly balanced by the mud fluid on the outside, so that when the swedge is removed the grout proceeds downward, forcing the mud fluid up on the outside of the casing until a balance is reached. The swedge nipple is then replaced and the casing pumped full of water or mud fluid, which forces the grout down the casing and eventually up the outside to its final resting place.

In this process it is necessary to know the exact location of the column of grout in the casing during the entire operation. There are two methods in common use for doing this: (1) After the top plug is inserted, the water pumped into the casing is very carefully metered and the depth of the plug calculated. (2) A more accurate method uses a device that will measure depths correctly within 2 in. in 5,000 ft. This device consists of a brass-incased lead weight suspended on piano wire which runs around a sheave calibrated with an indicator that reads directly in feet. The weight is placed in the casing immediately on top of the top plug and follows it down.



THREE METHODS OF CEMENTING OIL WELLS AGAINST WATER INTRUSION

Under-reaming—It is impossible to drill a hole accurate enough that the casing will be prevented from coming in contact at several points with the sides of the hole, but the condition can be greatly improved if the hole is under-reamed for 20 or 30 ft. at the bottom where it is desired to place the cement. In an unreamed hole, when the grout is forced up the outside of the casing, there will be no grout at the points of contact, with a deposit on the opposite side of the casing ranging from 3 to 4 in. up to several feet in caving formations.

Mixing Cement Grout—In the average cementing job relatively large quantities of cement must be placed in the well in a short period of time. The question of pumps for handling the grout was not so difficult to overcome as was the development of a mixer that would incorporate the water and cement thoroughly as fast as it could be disposed of in the well. The old method of mixing the grout in long troughs, from which it could run into a suction box, proved to be an expensive as well as a lengthy operation.

One of the first mechanical mixers was made from a piece of 12½-in. casing through which turned a series of propeller-like blades. This was attached to a feed hopper which fed dry cement into the mixing barrel. Water was fed into the mixing barrel through two holes near the center at the top. The mixer, mounted on the back end of a truck body, dumped the grout in a continuous stream into a suction box placed on the ground.

Then ordinary concrete mixers were used. These were held in the discharging position and a hose fed water into the drum continually as the cement was dumped in. The grout discharged into one end of a long trough and men with hoes gave it further mixing as it passed to the far end into the suction pipe.

The latest mixer designed consists of a conical hopper screened with a 2-in. mesh and screwed into the mixer, where a high-velocity stream of water is introduced through a nozzle. The cement is dumped into the hopper and, falling into the high-pressure water jet, is carried through a 4-in. pipe to the suction box. It is claimed that the stream of water under its high pressure creates a partial vacuum which draws the cement in at a rate in direct proportion to the velocity of the stream. The capacity of this mixer is 1,500 sacks of cement an hour. One of the large oil-well cementing companies, operating in nearly all oil fields, owns the patent rights on this mixer and will not permit its use by others for cementing wells in the United States.

Better Results—In the use of portland cement for shutting off water in oil wells, impermeability is probably the first thing to be considered, with strength also an important characteristic. Both are dependent on the water-cement ratio of the grout, becoming a maximum when the least possible amount of water is used.

The greatest improvement that could be applied to the present-day cementing process would be the development of a mixing device that will produce grout of a uniform consistency. In all processes known to the author the consistency of the grout will vary from fairly thick to exceptionally thin in the same operation.

Finally, within certain limits calcium chloride, 2 to 4 per cent, and calcium oxychloride, 7 to 10 per cent, is sometimes used to hasten hardening and to increase early strength. However, when an accelerator is to be used for the first time with any brand of cement, it has been found advisable to make a few tests to determine the best amount to be added.

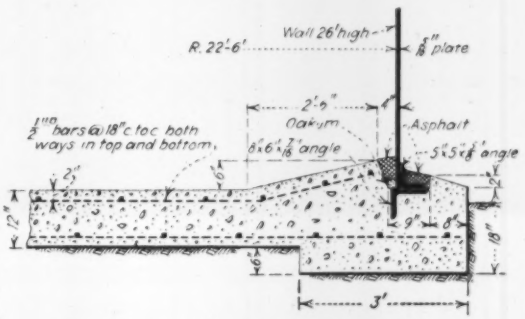
Texas-Oklahoma Boundary Surveyed in Seven Weeks

Despite zero weather and high winds, engineers of the Coast and Geodetic Survey of the Department of Commerce completed in seven weeks a survey of 110 miles of the 100th meridian, definitely locating part of the boundary between Texas and Oklahoma.

Making Joint in Water Tank Where Steel Shell Joins Concrete Base

By I. E. Flaa
Office Engineer, Spring Valley Water Company, San Francisco, Calif.

A REGULATING tank of 300,000-gal. capacity that was constructed recently in extending the distribution system of the Spring Valley Water Company of San Francisco was designed as a circular steel wall mounted on a concrete base. The design was such that the cylindrical steel shell is free to move, within certain limits, on the concrete base. The reasons for this design were that (1) it would lessen the danger of rupture in the lower seams in the event of an earthquake; (2) it would take care of expansion and contraction when the tank is empty, thus reducing the danger of stress in the



DETAIL OF JOINT AT CONCRETE BASE

joints that might cause leaks; and (3) it should increase the life of the structure as compared with an all-steel tank, because steel tank bottoms deteriorate more rapidly than do the shells.

The concrete base is 12 in. thick and is reinforced top and bottom with ½-in. square bars both ways on 18-in. centers. At the outer edge the slab was made about 18 in. thick for a width of 3 ft. in order to insure a good foundation under the side walls. During the excavation for the base a layer of loose sand lying in an inclined plane was encountered. To avoid the possibility that this sand would flow under the foundation, it was removed and replaced with a lean-mix concrete. Particular care was taken in mixing the concrete for the base slab to make it dense and watertight. The mix was designed to give a minimum strength of 2,000 lb. per sq.in. in 28 days, and this was considerably exceeded in tests made as the work progressed.

The watertight joint between the steel shell and the concrete base was obtained by forming a depression in the concrete at the time of pouring, in which was embedded an 8x6x$\frac{7}{8}$-in. angle set so it would be immediately beneath the steel shell. On this foundation was placed a 5x5x$\frac{5}{8}$-in. angle riveted to the bottom of the steel plate in the first ring of the superstructure. After the steel shell was erected the inside of the depression in the concrete around the base was first calked with oakum and then filled with an asphalt filler. The outside of the depression was also filled with the same material to keep the water from coming in contact with the two angles.

A full load test which put a pressure of about 11 lb. per sq.in. on this joint showed it to be absolutely watertight.

Temperature and Humidity Control in Rooms for Concrete Study

Automatic Devices Keep Heat and Moisture Constant While Test Specimens Age in University Laboratory

RESEARCH on portland cement concrete has received particular attention in the materials-testing laboratory at the University of California, notably within those fields that have to do with the effect of age on test specimens subject to different combinations of temperature and humidity. This series of tests, begun three years ago, required some means of constantly maintaining the air at a certain temperature and humidity in rooms where the specimens could be stored. Rooms were accordingly built in the basement of the laboratory where the desired conditions could be continued without variation year in and year out. To simplify operation, automatic devices were built and installed, some of wholly original design, which maintain the desired atmospheric conditions with a variation of less than 1 per cent.

A portion of the laboratory basement, about 24x36 ft. in plan, was partitioned off into six rooms, numbered 1 to 6 and arranged as shown in Fig. 1. All of these

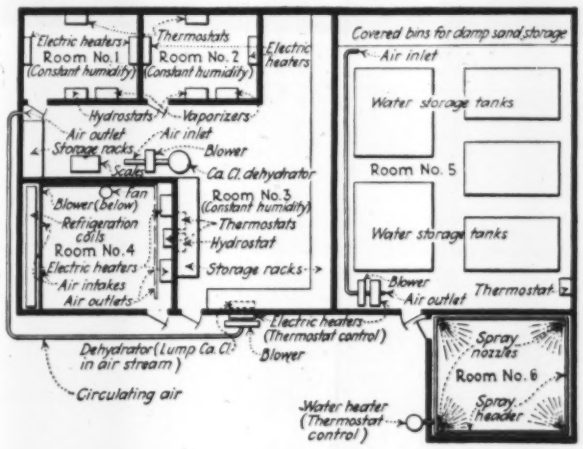


FIG. 1—PLAN SHOWING ARRANGEMENT OF SPECIMEN STORAGE ROOMS

rooms are equipped with electric heaters operated by thermostatic controls sufficiently sensitive to maintain the temperature constant within 1 deg. F. Five of the rooms are normally maintained at 70 deg. F. but at different humidities. The humidity is controlled in three of the rooms by sensitive hydrostats and in addition there is in room No. 3 an air-dehydrating device of novel design.

The hydrostat, shown diagrammatically in Fig. 2, is equipped with several strands of human hair about 9 in. long, stretched between two posts and passing through a loop of fine wire placed near the middle of the strands. The wire is attached to a very light spring-actuated lever the outer end of which dips into a mercury cup when the lever swings down. The change in length of these human hairs caused by changes in the humidity of the air raises or lowers this lever, thus breaking or making an electric circuit.

In the case of room No. 1 and room No. 2, where humidity is kept above that in the outer air, closing the circuit actuated by the hair strands puts into operation a relay that sends current through an electric coil immersed in water and opens a trap door above permitting water vapor to rise and mix with the atmosphere of the room. When humidity is raised by the desired amount the change in length of the hair in the hydrostat breaks the electric circuit and the vaporizer door closes suddenly.

Room No. 3 is maintained at 70 deg. F. and 50 per cent relative humidity and was made large because of the

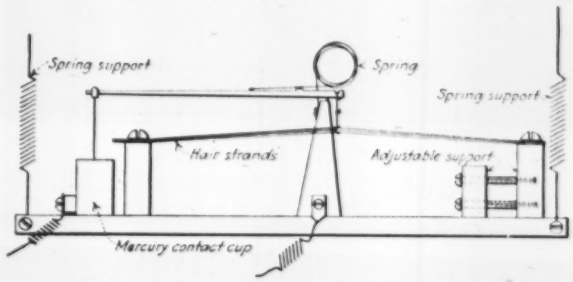


FIG. 2—DIAGRAMMATIC SKETCH OF HYDROSTAT FOR HUMIDITY CONTROL

relatively large number of specimens to be stored under these conditions. To insure constant temperature, air is circulated by means of a blower, the circulating air passing over coils of an electric heater, which is energized only when the temperature drops below the prescribed figure. The air inlet is in one corner of the room near the floor and the outlet is near the diagonally opposite corner near the ceiling.

Because 50 per cent humidity is lower than that of the normal atmosphere outside this room, unlike the case of rooms 1 and 2, it is necessary, to maintain the desired condition, to remove moisture from the air instead of supplying moisture to it. Air dehydration is accomplished by a device of original design shown diagrammatically in Fig. 3. When the atmosphere carries excessive moisture, a hydrostat similar to that already described operates a relay starting the blower. This forces air through the pipe in the bottom of the barrel and through an air diffuser in the bottom of a chamber containing a calcium chloride solution that absorbs moisture from the air. Above the solution the air current is baffled and screened so that none of the solution is carried out into the room. When the air in the room has been brought to the proper relative humidity, the hydrostat breaks the circuit and the blower stops.

This apparatus is simple and dependable and no difficulty has been experienced in maintaining humidity within 1 per cent of the predetermined figure. The

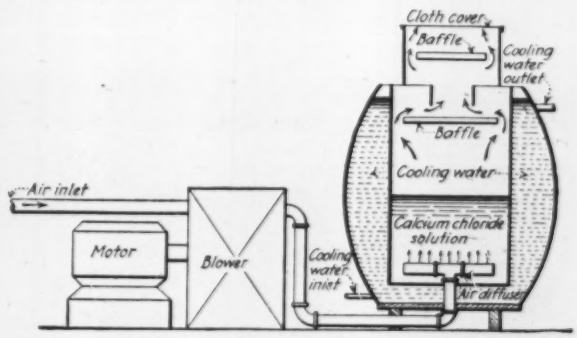


FIG. 3—DIAGRAMMATIC SKETCH OF CALCIUM CHLORIDE DEHYDRATOR

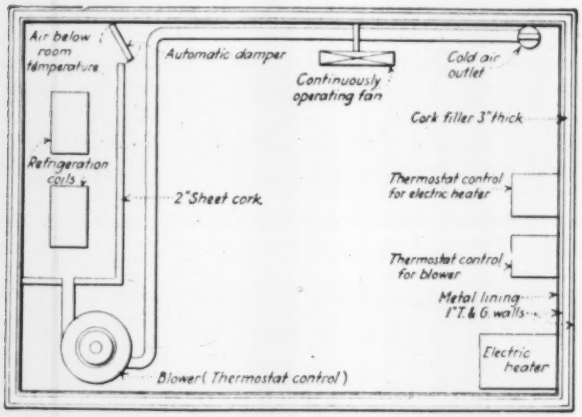


FIG. 4—SECTION THROUGH REFRIGERATION ROOM (NO. 4) SHOWING INSULATION

calcium chloride solution gradually weakens, however, and must be strengthened every few days by the addition of more of the salt. The cooling water-jacket was found necessary to prevent heating the solution and thus decreasing its moisture-absorbing capacity.

Room No. 4 is designed for tests to determine the effect of alternate high and low temperatures on certain specimens and also to determine the thermal coefficient of expansion. This room, unlike the others, is insulated with cork, like a refrigerator. It is equipped (1) with electric heaters which are thermostatically controlled so that any temperature above normal outside temperature may be secured and (2) with refrigeration coils to lower the temperature when desired. The cooling coils are housed in an insulated cabinet in which are dampers arranged to be opened by a thermostat relay when the room temperature becomes too high. The same operation that opens the dampers starts an electric blower, which circulates air through the four large fin cooling coils of the refrigerating unit. With this arrangement, temperatures may be maintained at any desired point from 10 to 104 deg. F. with a variation of less than 1 deg. F. Fig. 4 is a cross-section through room No. 4.

Room No. 5 is a storage room in which temperature is controlled by the same type of apparatus as in room No. 3. Here are tanks for the storage of specimens under water and bins for the storage of specimens in damp sand. The temperature is kept constantly at 70 deg. F., but the humidity is not controlled.

Room No. 6 is used for storing specimens to be maintained in a saturated atmosphere. It is served by several atomizing water sprays that operate continuously delivering water that has passed through a gas water heater controlled by an electrical thermostat set for 70 deg. F. No hydrostat is needed in this room.

The materials-testing laboratory at the University of California is under the direction of Prof. R. E. Davis. A description of equipment designed at this laboratory for making special tests on concrete will be given in an article to be published later.

Concrete Plant Placed on Spoil Bank to Obtain Gravity Flow

Contractor on Amarillo Water Reservoir Finds New Use for Waste Material Embankment in Level Country

THE ADVANTAGES of gravity handling of materials and concrete at a central mixing plant are usually hard to obtain on construction work in sections of the country as flat as some of that near Amarillo, Tex. The contractor constructing a 5-m.g. reinforced-concrete reservoir for this city's new water-works system, described in *Engineering News-Record*, June 2, 1927,

FIG. 1—COVERED WATER RESERVOIR FOR AMARILLO, TEX., UNDER CONSTRUCTION
Note hopper on trestle from which buggy distribution of concrete is made for the reservoir roof.

p. 904, was confronted with an extremely level location for this construction plant. After considering blocking and temporary pile foundations for the several units in his concreting plant, he developed the plan shown in Fig. 2.

The reservoir is practically square, 190x210 ft., and about 20 ft. deep. Part of it is above the present ground surface, but enough excavation yardage was available to build a considerable spoil bank if the material was all put in one place. The reservoir is to be entirely covered with this waste earth after completion, so that building such a spoil bank has not caused any great change from usual procedure.

Planking was placed over the top of the spoil bank, and a 6-ft. division wall was erected to separate the sand and stone storage. The cement house and mixer charging floor were at this same elevation, so that wheelbarrow charging was done on level runways. A retaining wall tying into the cement shed formed a location for the 1-yd. mixer at the foot of the embankment 9 ft. below the charging floor. The mixer discharged into a hopper which fed the 8-cu.yd. mast bucket, which at its at-rest position was about 7 ft. below the mixer platform. Concrete distribution was by chutes from an 80-ft. mast. Both direct chuting and chuting to a distributing hopper from which the concrete was wheeled in buggies was used. A Fordson-operated hoist was used for the mast bucket; the mixer was run by a 20-hp. electric motor. A roadway from the railroad spur on which all concreting materials were delivered was kept open between the storage piles and the cement shed.

The Kimball Construction Company, Colorado Springs, Colo., is the contractor on this work. H. B. Jones is city engineer and Marvin Nichols chief construction engineer for Amarillo, Tex.

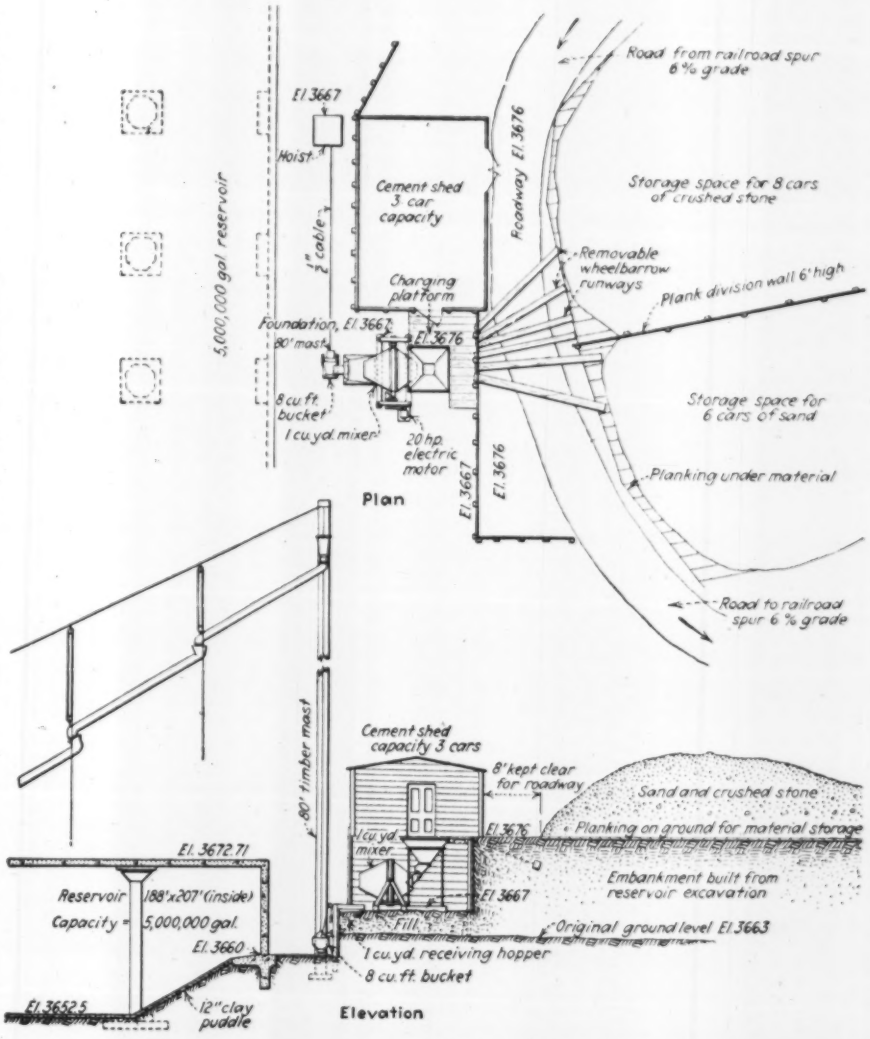


FIG. 2—CONCRETING PLANT ERECTED ON WASTE EMBANKMENT PERMITS GRAVITY HANDLING OF MATERIALS

India Experiments With Concrete Roads

Experiments are being made with concrete roads in the United Provinces of India. More than 16,500 sq.yd. of concrete road has been laid in Benares, and a 14-mile stretch is to be laid from Benares to Moghal Serai. The Allahabad Improvement Trust is also reported contemplating laying a long stretch of concrete road through that city. The experiments are believed a manifestation of the government "good roads" movement. Concrete construction in India, it is said, would prove a great boon to the depressed Indian cement industry.

Europe's Largest Graving Dock Opened

The Gladstone graving dock at Liverpool, which was the first section of the $37,500,000 Gladstone system of docks at Liverpool to be completed, was thrown open to shipping for the first time in December, 1927.

It is claimed that the dock, which is a permanent dry dock and can be used as a wet dock when required, is the largest in Europe. Powerful pumping machinery to clear it of water when it is required for use as a graving dock can remove the entire contents, amounting to about 44,000,000 gal., on a tide rising to 28 ft. above bay datum, in 2½ hours.

According to the original design, entrance to the dock was from the River Mersey. In practice this was found to be unsatisfactory on account of the silting, which involved considerable expenditure for dredging. Therefore in March, 1921, the dock was taken out of commission, and a sea wall inclosing what was formerly the original entrance was built. On completion of the system of docks several months ago, a new entrance was constructed, approached from the vestibule, or turning dock, as it is known, which has a water area of about 22 acres. There is adequate space for a 1,000-ft. liner to maneuver from the vestibule into the graving dock.

SEVENTH OF A SERIES OF ARTICLES

Today in the Mississippi Flood Area

Engineering and Human Conditions in the Basins and Along the Levees as an Engineer Sees Them

VII—New Levee Designs and Their Construction

By W. W. De Berard
Associate Editor, Engineering News-Record

HERETOFORE levees on the Mississippi have been built on the principle of using as little material as possible *within safe limits of percolation.* Frequently in the highest floods, seepage comes to the surface above the toe of the levee. But after the experiences of 1927 the time has come when seepage or percolation is to be kept well within the land slope of the proposed strengthened and raised levees. Former sections accomplished this result only so long as the water remained below the 3 ft. freeboard margin.

A new era in levee design in the valley is here, because—almost for the first time—economy has not had to be the ruling factor. Limited funds hitherto made it necessary to build the levees just barely safe enough, and in addition, they have practically been considered as emergency structures because of the comparatively short time the water was supposed to be at crest heights.

In 1898, H. St. L. Coppee in a paper presented to the American Society of Civil Engineers (*Transactions,* Vol. XXXIX, p. 229) on "Standard Levee Sections" stated that "under continued and constant pressure, as in the case of canal embankments, many levees on the Mississippi would not remain intact for six months." Rarely in the Third District, with which Mr. Coppee was connected as civilian assistant engineer, are the levees under strain longer than 60 days. Most of the Mississippi River levees showed seepage when water exceeded the 3 ft. margin of safety, and they still do; but where the foundation is sound and the section and construction up to standard, such seepage has been considered unobjectionable.

During the high water of 1897 many borings were made in levees to determine the line of saturation, and Mr. Coppee in his discussion presented 53 sections. A mean curve showed the seepage line to be a parabola, but in each individual section it was far from it. He concluded that the seepage slope for small levees was about 8 to 1 and for large sections about 5 to 1, nearly always in a curve dropping sharply at first and diminishing in inclination as the ground level is approached. He recommended continued observations in subsequent floods. Such later observations did, in fact, check his results, but various materials are found to give different percolation lines, depending on the material. All kinds of material must be used in levee construction. The builder has no choice, for his amount of money is fixed and so is location of the levee.

Essential data on which to design levees consist of a knowledge of the structural properties of the material to be used and of the mechanical and perhaps physico-chemical properties as well. No extended scientific study has been made along these lines. No scientific analyses of the physical properties of the different kinds of material are available, at least in readily usable form for field application. Mr. Coppee estimated the relative strength of various levees to resist deformation due to seepage in the following order: (1) Buckshot clay and gravel tamped in shallow layers. (2) Buckshot artifi-

DRAGLINE EXCAVATOR WORKING ON A LEVEE
The dragline machine removes old crown down to banquette elevation preparatory to coming of tower machines.

cially mixed with sharp sand in shallow layers. (3) Buckshot or clay. (4) Heavy strong soils. (5) Coarse sharp sand. (6) Light soils. (7) Fine sandy rounded particles.

There is a feeling among the engineers of the various districts that some such study of levee materials as was reported in the dozen articles in *Engineering News-Record* by Prof. C. Terzaghi in 1925 and 1926 should be made, and if possible simple field tests devised from which it would be possible to vary the levee section from the standard and thereby approach in the finished structure a levee of more nearly uniform strength and factor of safety.

Official Views on Design—In view of these facts it was with considerable interest that there was sought from the Mississippi River Commission engineers the basis for the new sections. First it was learned that the matter had been discussed thoroughly in all of the districts, and that the final section represents the views of the local levee board engineers as well as those in the M.R.C. staff. With minor exceptions they are in agreement. In the upper reaches a roadway on a banquette is much desired, while the lower river is well supplied with back-levee roads and in consequence there is not so much insistence on a banquette road.

Points to be covered in levee design include provision for seepage, freeboard, crown width, height of banquette, river and land slopes and borrow pit.

Line of Seepage—Just as Mr. Coppee came to no general conclusion as to seep line, so the present-day engineer finds that the variation in the materials is so wide that all he can do is to state outside limits. The Gatun dam with its core of hydraulic fill is quoted as having a seep line of 5 to 1, but it was built of carefully selected material. Since the observations of Mr. Coppee's day and those made subsequently indicate that the seep line lies within 5 to 1 and 8 to 1 limits, a 7 to 1 line was adopted upon which to base the standard section: the landside slope is to contain a 7 to 1 saturation line as a minimum.

Refinements and variations of back slope to conform to the foregoing requirement vary somewhat in the M.R.C. general recommendation and in that of the districts, but all contain the 7 to 1 saturation line. They all take into account the fact that excess material above the line of saturation only increases the force tending to push the dry section into the saturated material or to start a slide along some semi-saturated plane, producing the usual slough. However, banquettes to buttress against such sloughs are not provided in the M.R.C. recommendation, since now the saturation line is supposed to be retained entirely within the section. If a construction road is required, it is to be built on a shoulder superimposed on the landside slope about 5 ft. below the crown.

For the main river south of Cape Girardeau the M.R.C. land slope varies from 4 to 1 to 6½ to 1 and must contain completely a saturation line of 7 to 1, springing from a point in the riverside slope 2 ft. vertically below the crown. For the river above Cape Girardeau a somewhat lighter section is recommended, but still to contain the 7 to 1 saturation line. In the First and Second districts for levees between 10 and 15.9 ft. in height a 5 to 1 landside slope is proposed. The slope is increased to 6 to 1 for levees from 16 to 32.9 ft. in height and to 6½ to 1 for levees 33 ft. and higher. No banquette is called for, but a roadbed in the form of a shoulder superimposed on the landside slope of the levee is to be provided for construction and inspection purposes. The Third District shows no road shoulder and gives slopes of 5.7 to 1 for 27 ft. height, 5.9 to 1 for 32 ft., 6.1 to 1 for 37 ft. and 6.2 to 1 for 42 ft. height.

Many of the local levee board engineers contend that a sub-levee filled with water at the base of the landside slope answers as a buttress equally as well as a sub-banquette, whereas others feel safer if the space is filled in solid (recently dredges have been used for the latter purpose). With water-filled sub-levee there is necessity of filling with water, which is often done by siphoning over the main levee top, as well as maintenance to be sure the sub-levee does not break and let the water out. The sub-levee has the advantage of directly reducing the static head on the lower portion of the levee and the ground landward from the toe of the levee, thus reducing the tendency to upward explosions, causing sand boils.

River Slope—The present 3 to 1 river slope is made 4 to 1 in the new section. It adds resistance to wave action, facilitates maintenance operation, such as grass and

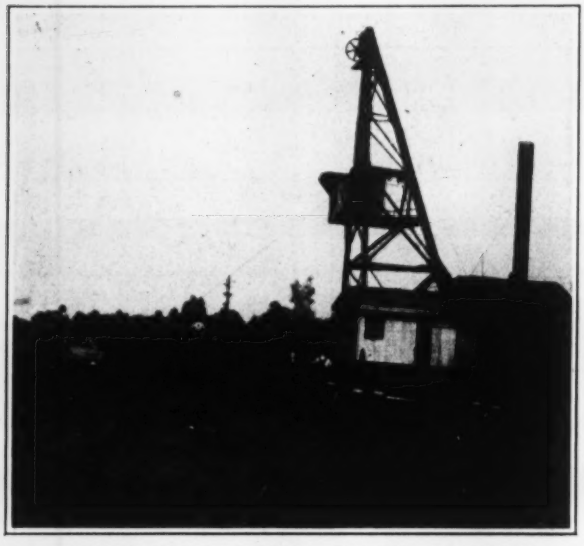
TOWER MACHINE WORKING ON BANQUETTE

The main tower is on the banquette of the levee and the tail tower is at the far side of the borrow pit. The borrow pit area is cleared and the stumps are dynamited and removed by stump-pulling crews, equipped with large tractors, before the excavation is begun.

weed cutting, and reduces the chance of slides during construction. Since 25 per cent excess material is added to provide for shrinkage, the present 3 to 1 slope becomes nearly 2 to 1 when first constructed. Some materials will not stand at that slope, and troublesome sloughs occur, causing a plane of slippage difficult to eliminate without excavating. The 4 to 1 slope will tend to remedy this construction hazard.

If the slope is to be paved with a concrete slab shortly after construction, a 3 to 1 riverside slope is considered entirely sufficient.

Freeboard — The present freeboard of 3 ft. is to be increased to 5 ft. to provide more effectively against wave action, which gave much trouble in the 1927 flood. Since freeboard elevation is set at the height of the



TOWER MACHINE COMPLETING ENLARGEMENT

predicted flood for which the levee is built, it must, to have any factor of safety, provide for varying characteristics of the expected flood. The 1912 flood was the basis for the existing provisional grade line. The 1927 flood plane was not a uniform distance from the 1922 flood plane confined, varying from 1½ to 9 ft. below the M.R.C. grade. The confined 1927 flood varied from 4 ft. below to 6 ft. above the provisional grade. Human factors, accidents changing conditions, such as levee relocations, spur dike removals and entry of tributaries with especially heavy discharges, all make a 5-ft. freeboard decidedly desirable.

Crown—Usual practice in inspection is to use an automobile and look over both slopes from the crown. A width of 12 ft. is about the minimum that can safely carry a machine. The present 8 ft. is dangerous. A 10-ft. width is sufficient for the safety of the levee, but on the Yazoo, where a 10-ft. crown is used, it is found hazardous for travel when slippery. A flat crown, rather than a so-called "bicycle" topping of 1 ft. as practiced in some of the districts, is preferred. In case of emergency the extra width is a decided advantage in giving more room for operations.

Road Shoulder—The road shoulder probably would be set at 5 ft. below the crown, the same elevation as the predicted maximum flood plane; it will thus give sufficient base for increased heights that ultimately may be necessary. As to a 24-ft. width and 20 to 1 slope, which is probably what would be used, this is ample for a hard road of 16-ft. width and will still leave room for the storage of materials during an emergency.

The necessity of a road adjacent to the levee is paramount in case of a flood fight. Transportation over the usual dirt road back of the levee is difficult, if feasible at all. Water transportation is slow and often not available to the point of danger. It is hardly to be expected that levee construction will ever attain such degree of excellence as not to require constant vigilance during high flood stages. In 1922 Old Town levee was saved largely because a concrete road made the supply base at Helena easily accessible. Transportation of men and materials to a given point in the minimum of time adds a factor of safety not easily obtainable in any other way. Those reasons and the added means of supervision and maintenance at all times are considered sufficient to warrant inclusion of a hard road on the section where there is none at the base at present.

Borrow Pit—The present specifications call for a 40-ft. berm to be left from the riverside toe to the beginning of the borrow pit; then a drop of 3 ft. and a slope of 1 on 50 carried back to get the required amount of material.

AVAILABLE MATERIAL IN BORROW PITS AT DIFFERENT SLOPES

Distance From Berm, Ft.	Slope 2:1 for 6 Ft., Then 50:1, Cu.Yd. Per 100-Ft. Sta.	Slope 2:1 for 6 Ft., Then 25 to 1, Cu.Yd. Per 100-Ft. Sta.
6	33	33
56	681	778
106	1,515	1,885
156	2,533	3,367
206	3,737	5,219
256	5,126	7,441
306	6,700	10,033
356	8,459	12,996
406	10,403	16,330
456	12,533	20,033
506	14,848	24,107
556	17,348	28,551

The accompanying table shows the quantity available per 100-ft. station for different distances up to the usual limit of haul of the levee tower machines.

This brings up the question of how these higher levees with greatly increased sections are to be built. Where is the material to come from and how is it to be put into place? There should first be discussed, however, the question of foundations.

Foundations—So far, no change has been suggested in the method of preparing foundations, which requires all stumps to be cleared out, a procedure usually cared for by a stump crew after cutting out all of the trees and clearing out the underbrush. The stump crew dyna-

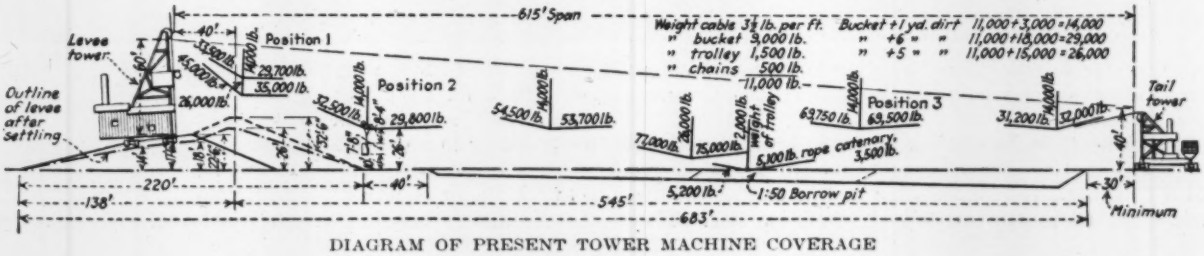


DIAGRAM OF PRESENT TOWER MACHINE COVERAGE

mites the stumps and then snakes them out with a tractor, maintaining close contact with shovel and bucket operators to remove everything in the way of roots down to 4 in. in diameter.

An exploratory muck ditch is still maintained in the new section, but it is recommended that it be placed a little to the river side of the center line, so as not to interfere with center stakes.

It is believed that the added slopes will provide so much wider base that in practically all ground little difficulty will be experienced from pushing up of the material. For cutting off seepage, where this cannot be done effectively by muck ditches, there remains the possibility of sheet piles, which heretofore have always been considered too costly to use. Special designs will be required in such cases. In fact, much more special designing is considered inevitable as the height increases. With sections 30 ft. high running upward of a million yards per mile, the total cost will easily bear a burden of engineering cost sufficient for the required investigations of foundation exploration, of material available, and of foundation characteristics and designs to meet the conditions encountered.

The accompanying table from the First and Second Districts office, Major Donald H. Connolly, U. S. Army, district engineer in charge, gives yardage per mile for sections up to 40 ft. in height, not including roadway shoulder.

Construction Problems—No particularly grave difficulties are apprehended by the men in the field over constructing the new higher levees or reconstructing or raising the old ones. Sections are reproduced herewith of new levees, and opposite them sections which are superimposed on the existing average section 22 ft. high in the Third District, where some of the highest sections proposed would be built were all the highest floods to be retained between levees. That is on the assumption of 2,250,000 sec.-ft. at Cairo, 2,850,000 sec.-ft. at Arkansas City and 2,650,000 sec.-ft. at Old River.

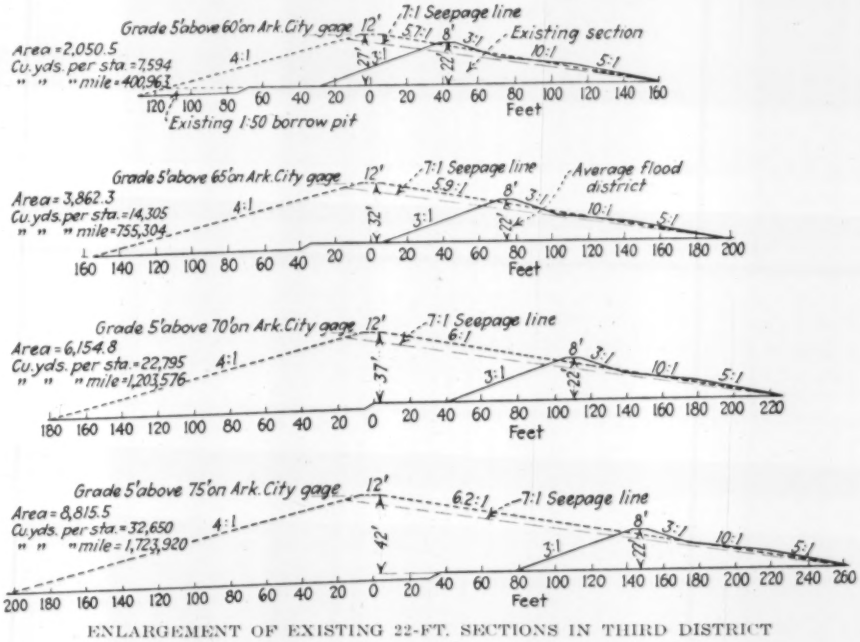
Levees of the larger sections today are built by tower machines, draglines and steam shovels with long booms, and to a limited extent with tractor- and mule-hauled wagons loaded by shovel or by elevating grader. Last season dredges did a considerable amount of filling at Mound Landing and Pendleton crevasses and other points. The available working season is so short between high-water stages that large-capacity outfits are essential, which practically limits the bulk work to the machines with buckets and shovels of 5- to 7-yd. capacity.

YARDAGE PER MILE FOR SECTIONS WITH 40-FT. SHOULDER

Height	Base	Cu.Yd. Per Mile
15	147	233,318
20	212	438,029
25	262	669,768
30	312	950,400
35	379.5	1,339,800
40	432	1,736,539

Tower Machines—The tower machines were designed to operate with 5-yd. buckets but have been equipped pretty generally with 6-yd. buckets. This added size has pulled down the catenary of the 1⅜-in. carrier cable and reduced somewhat the speed at which material from the longer reaches of the borrow pit can be delivered. This is now about 2½ minutes per trip as a maximum, but the average has been about a trip per minute. The maximum haul now utilized is about 650 ft.

Major John C. H. Lee, engineer of the Third District, states that it is feasible, in his opinion, to put back the 5-yd. buckets, raise the towers perhaps 20 ft., at least the tail tower, weight it down and perhaps add shear fins on the tractor treads to prevent side slip, and by this means get a distance of 1,000 to 1,100 ft. between towers. This would give a working borrow pit with the river end about 850 to 900 ft. from the center of the levee. In many cases it will be feasible to increase the 50 to 1 slope in the pits, but in others it will not, and there will not be enough room or material between levee and river. All of these cases will need to be made the subject of special construction design.



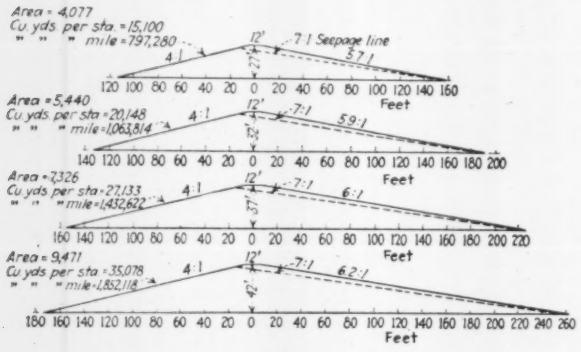
ENLARGEMENT OF EXISTING 22-FT. SECTIONS IN THIRD DISTRICT

In case there is found so much of the long-haul work that new machines must be built, electrically operated equipment will be one of the first considerations, since power is cheap in this vicinity and the fueling of the present equipment is one of the serious handicaps. Railroad equipment is mentioned as often as anything else when discussing the limiting distances of the present equipment. All of the recommendations carry costs at 40c. per cubic yard, which it is felt will cover rail haulage from 3 to 5 miles, within which distance material is sure to be obtained.

Dragline and Shovels—Draglines will find limits in the number of times they can relay the material. There will always be a place for them, but they are out of the question when the pits are 1,000 ft. away. For loading, railroad- and tractor-hauled equipment shovels and small draglines will be needed.

Dredges—Perhaps the most thought at present is being given to the possibilities of utilizing the large capacities

in dredge equipment available and idle much of the year both in and out of government service. On the river side of all present levees is the borrow pit from which these levees were made. Major Lee's proposal is to utilize dredge equipment during high water, pumping material into these pits (where they lie in shoal water, of course).



PROPOSED LEVEE SECTIONS

The tower machines later on would use this material to build up the higher sections. Further, there should be opportunity to pump material into the levee section during low stages of the river if favorable sites of suitable material can be located within economical pumping distance. In each case a special survey of the situation will have to precede any work, and no general statements can be made, but with million-yard-to-the-mile sections dredging, with its high overhead charges, becomes a possible factor to be considered. Last season's flood did a lot toward making various types of equipment better known in different fields than that to which they are regularly assigned. This new thinking with reference to the possibility of utilizing in levee construction the dredge equipment, ordinarily used only during low water to keep open the channel across bars, grew out of the necessity of closing the great Mound Landing crevasse before the advent of another high-water season.

Scarcely a day passes in the district offices but that a machinery man, usually a research engineer, appears and is received with courtesy and told the problems in detail so that he may use his ingenuity and that of his company's staff to help work out some cheaper, more efficient, faster way of handling the enormous yardage that is to be placed in any program that is adopted.

The company that built the tower machines doubtless has plenty of talent at work now developing electrically operated equipment to cover greater distances with speedier round trips than the present machines.

Generally considered, the engineers in the valley are not at all concerned over the construction features. Large quantities have long ceased to worry them. Once finances are available, construction will soon be under way.

Speaking of finance, the present delay in passing appropriations and the uncertainty as to proportionate cost allocated to the local districts has precluded getting any contribution from them for the time being. In consequence the commission has taken over the machine cost completely and has agreed to credit the levee boards with their third interest in the levee machines, using the credit to match the two-thirds of the commission under the existing law. This amount is providing sufficient money to put the machines in repair for the 1928 construction season when Congress will have passed some kind of appropriation bill.

Some Details of Storm-Water Sewer Overflows

Actual Examples From Practice at Hartford, Conn., With Explanations of Local Governing Conditions

By Alden Wells
Division Engineer, Department of Engineering, Hartford, Conn.

STORM-WATER overflows for combined sewers are connected to the sewers in a variety of ways, some simple, some complex, some good, some not so satisfactory. Just which is the proper type of detail in any particular case must be determined from the facts in that case. It is proposed here to discuss some of the considerations that enter into the selection of the type of overflow suitable in a particular location. The illustrations show several types of overflows that have been built in recent years at Hartford, Conn., and are selected to show ways in which various conditions have been met. They represent the results of observation of some 30 or 40 other overflows in use in that city and the study of some literature on the subject. Each overflow figured is described in notes just below it and is also referred to in the general discussion.

An overflow must have the capacity to give the relief required. It should be possible to adjust its action to changes in the required relief which may occur over a period of years. Further, an overflow may be designed to provide the means for diverting the flow at times when the sewers are being flushed, cleaned or repaired. It may be combined with a device for excluding sediment from the intercepting sewer. These possibilities should be considered in planning the details of any overflow.

In this article "overflow" means the structure or device by which, in time of storm, the surplus water is diverted to the conduit and thence to the storm outlet. The main sewer below the "overflow," carrying the sewage to its normal point of discharge, is here called an "intercepting sewer," whether truly such or not. The sewer conveying the diverted storm surplus to a more convenient outlet will be spoken of as the "conduit" and the sewer immediately above the "overflow" is termed the "branch sewer."

Types of Overflows—Overflows are of three common types: (1) Mechanical overflows, consisting of balanced or float-operated gates. These are suitable where frequent inspection and skilled attention can be had. (2) The leaping weir, where the normal, slower flow drops through a small opening in the bottom of the sewer or manhole and is thence carried away, while the faster-flowing storm water jumps over this small gap and continues on to the conduit. (3) The simple overflowing weir type, where a dam is provided which diverts the normal flow to the intercepting sewer, but the storm runoff, being deeper, overtops the dam and thus makes its escape. The third type is the most common. The discussion that follows applies particularly to this third and simple type, but much that will be said can also be applied to the other kinds of overflows. All of the illustrations are overflows of the simple weir type.

The simplest and probably the most common overflows are made by tapping into the wall of a manhole above the top of the sewer, or sometimes into the upper part of the sewer itself, and setting in a pipe outlet. Such an overflow is easily built but is less efficient than more elaborate

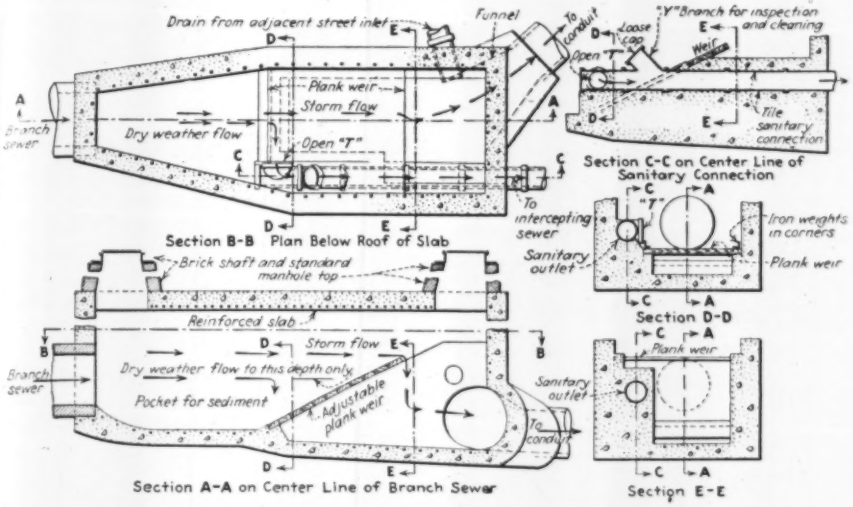


FIG. 1—OVERFLOW WITH ADJUSTABLE SLOPING PLANK WEIR

Three overflows similar to this have been built at Hartford and two others that were modifications thereof. The sloping weir consists of treated, matched plank set on offsets in the chamber walls. The height of the weir may be adjusted by adding or removing planks of various widths. The whole flow of sewage may be diverted into the conduit by removing all the planks. The offsets on which the planks rest were extended to provide for this adjustment, and a level section at the end was made to provide a place to store any planks temporarily out of use. Steel angles or rails were placed on top of the plank weirs at either side of the chamber to weigh them down. The sediment pocket between the inlet and the weir was provided to meet the expectation that when the tributary territory becomes built up the storm flow will carry the sediment over the weir to the conduit and out. The tests of this feature will not come for a period of years until the upstream areas are more densely developed. Meanwhile the sediment can be shoveled over the weir where the falling storm water will wash it away, or it can be removed by hand through the manhole opening above. The normal flow makes a right angle turn into the open branch of a "T" set on the end of connection to the intercepting sewer. To permit of inspecting and cleaning this connection a capped "Y" branch was set near the weir similar to the clean-outs used in plumbing work. By contrast with Fig. 2, note that the storm outlet and weir shown above are aligned with the branch sewer entering the overflow, while the outlet to the interceptor is slightly to one side.

designs. It does not reach its full capacity as an overflow until the hydraulic grade in the sewer has risen up to or above the top of the storm outlet. Further, due to the current in the sewer rushing past the overflow and the losses that occur at any orifice, the capacity of an overflow built in this manner is seldom equal to the capacity of the pipe which was tapped into the sewer. Yet because of its simplicity many overflows will probably continue to be built in this way.

Required Features—An overflow must have capacity to pass over into the conduit the quantity of water desired within the depth limits which the hydraulic grades permit. The area above the weir and below the maximum height to which water is to be permitted to rise must be adequate to accomplish this. The weir must be long enough to give this required capacity. The velocity of the water in the sewer approaching the overflow and the relative directions of that velocity and the crest of the weir should be taken into account in figuring the length of weir required. Actually the writer always prefers to allow a little extra length of weir beyond that figured as necessary.

The runoff and measure of relief required at any given point may change from time to time as the tributary territory develops, as more sewers are built or as additional overflows are added at other points, either on branch sewers or on the intercepting sewer. The amount of storm relief that is desirable is sometimes partly a matter of experiment. Consequently it may be necessary to alter the capacity of an overflow at various times after it is built, and to permit this it is desirable that the height of the weir may be varied without undue labor, or damage to any part of the overflow. Note the weirs built of matched plank in Figs. 1, 2, 3 and 5.

The storm flow should pass through an overflow and out to the conduit with the least possible loss of velocity, carrying with it any heavy grit or sediment it may have picked up. Usually the storm load serves to flush out a combined sewer, and this débris should be disposed of through the conduit rather than be allowed to clog the intercepting sewer. The overflow should be designed with that in mind. To accomplish this the weir, and the outlet through which the storm water passes to the conduit, should in general be placed directly opposite the inlet of the branch sewer, the connection to the intercepting sewer being at one side if necessary. A weir with a sloping upstream face (Figs. 1, 2 and 4) is more likely to pass sediment than one with a vertical wall.

The stream of sewage is likely to be considerably broken up in passing over

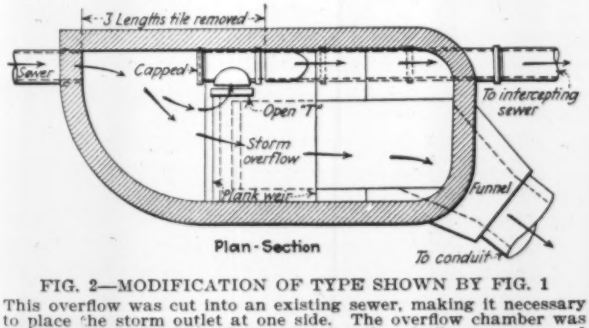


FIG. 2—MODIFICATION OF TYPE SHOWN BY FIG. 1

This overflow was cut into an existing sewer, making it necessary to place the storm outlet at one side. The overflow chamber was built around the sewer, then a few lengths of tile were removed from the sewer and a "T" branch was set in place on the end of the sewer just inside the weir. The closed end of this pipe diverts the stream coming from the sewer, directing the storm flow toward the weir instead of straight on down the sewer. The curved walls of this overflow were built of brick, that material being well adapted to working around the old sewer.

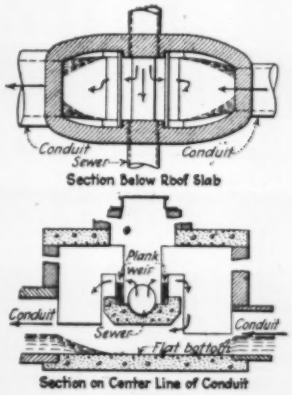


FIG. 3—OVERFLOW WHERE RELIEF CONDUIT PASSES UNDER EXISTING SEWER

Part of invert of the sewer was left in place, being carried on a concrete bridge through the overflow chamber. Low plank weirs, held in place in slots between pilasters in the walls, provide a means of adjusting the height at which the storm flow will spill over. By removing one of these planks and placing a sand-bag dam in the sewer the entire flow can be diverted into the conduit. To obtain sufficient cross-sectional area in the conduit under the sewer it was necessary to build a short section of this invert with a flat bottom. Three other overflows of this type have been built, except that the sewer passed close to the wall of the overflow chamber and there was only a single weir of the free side of the sewer.

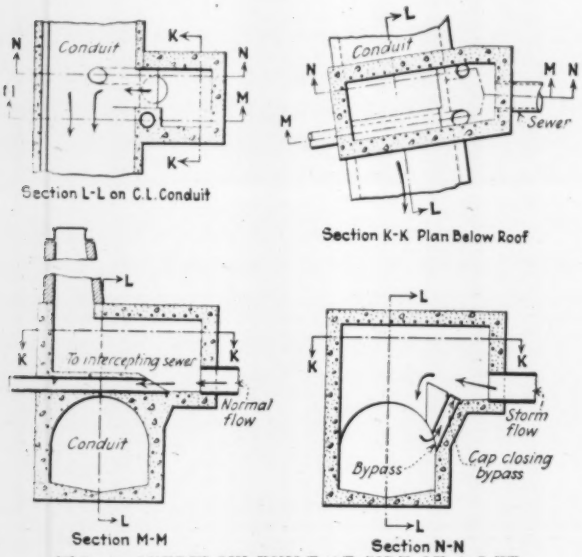


FIG. 4—OVERFLOW BUILT AT SIDE OF A 7-FT. CONCRETE HORSESHOE CONDUIT

Has a sloping weir of concrete which cannot be conveniently changed. Considering the circumstances in this case, the height of this weir is not likely to require adjustment. The weir is directly opposite the entering sewer, while the outlet for the normal flow is slightly offset. Provision to bypass the normal flow into the conduit is made by setting a tile vertically down from the base of the weir, the top of this pipe being closed with an ordinary vitrified cover which can be easily removed or replaced.

any weir, no matter how carefully designed. To gather this eddying mass of water back into a solid stream and to minimize the loss at the orifice it is best to build a short section of funnel at the connection to the conduit (Figs. 1 and 2).

To facilitate sewer cleaning, making connections or repairs or for other purposes it is sometimes convenient to divert temporarily the normal dry-weather flow

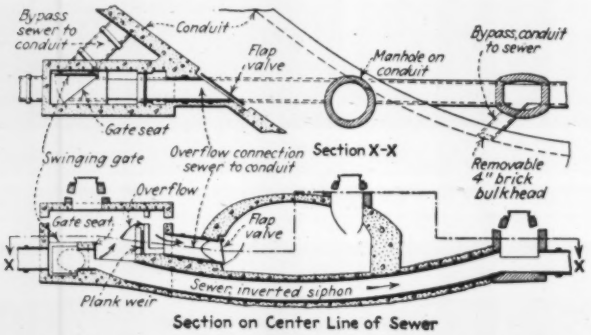


FIG. 5—CROSSING OF CONDUIT OVER SEWER WITH BYPASS EACH WAY AND OVERFLOW

During 1927 a conduit was built to inclose the flow of a brook which roughly paralleled a 24-in. tile sewer. At one point the conduit had to cross the sewer. This was accomplished by building a shallow inverted siphon for the sewer. The siphon was built of tile pipe surrounded with concrete, the spigot ends of the tile being trimmed to form the curved grade of the siphon. Advantage was taken of this crossing to insert an overflow from the sewer to the conduit, a bypass to divert the whole flow of the sewer into the conduit if that is desired, and also a reverse provision to bypass the small dry-weather flow of the conduit into the sewer should that ever be necessary. For this last a pipe was laid from the conduit to the manhole at the downstream end of the siphon, its end at the conduit wall being closed with a brick bulkhead which could be easily removed whenever this cutoff is wanted. The bypass from sewer to conduit was provided with particular reference to the possible need of cleaning the siphon. It leads from the side of the manhole at the upper end of the siphon. The end of this bypass is closed with a swinging gate such that when the bypass is opened the same gate closes the entrance to the siphon. Beyond the gate there is a second well or entrance to the top of the siphon for use in cleaning. Above and just beyond this second well is a vertical plank weir governing an overflow connection to the conduit directly over the siphon. The end of this last is protected with a flap valve set into the wall of the conduit. The skew section of the conduit along the center line of the sewer and siphon gives a very distorted view, the more so as the conduit curves at this point. The conduit was an 8x8½-ft. reinforced-concrete horseshoe, with semicircular arch.

through the storm outlet. Experience shows that this need occurs, even though not foreseen at the time the overflow was built. Thus the bypass shown in Fig. 5 was used within four months after that overflow was completed, and the weir planks in Figs. 2 and 3, located in another part of the city, were taken out for a period of some weeks' duration about a year after those overflows were built. When overflows with masonry weirs have been cut through to divert the normal flow, it is a rather unsatisfactory job, after the need for diversion has passed, to repair the masonry weir while sewage is flowing by. All of the overflows shown in the illustrations herewith have some provision by which the normal flow can be diverted into the conduit if necessary.

In some cases it may be desirable to collect some sediment from the sewage before it enters the intercepting sewer. Such provision is made in the overflows shown in Figs. 1 and 2.

The writer recalls one case in which a screen or baffle was built to catch floating débris and keep it from being carried over the weir into the stream into which the conduit emptied. This provision was requested by the owners of property bordering on the stream. No such device is shown in any of the illustrations with this article.

A sewer overflow should be so planned that it can be built with the labor and materials usually available on a sewer job. Provisions for future adjustments should be such that they can be executed by ordinary labor under the trying conditions that exist inside a sewer manhole. These requirements bar the use of elaborate mechanical devices or intricate layouts. Each overflow shown in the accompanying illustrations was built by the contractor's regular force as an incident of some sewer contract.

Gas From Sewage of Birmingham, England

Production of power of gas from the sewage-sludge digestion tanks of Birmingham, England, has been practiced on a small scale since 1921, when John D. Watson, then engineer of the works, installed a 34-brake-horsepower gas engine for the purpose. In 1925 Mr. Watson's successor, H. C. Whitehead, investigated the possibilities of this method of gas utilization, with results that led him to install a gas-utilization plant on a considerably larger scale, apparently with the idea of ultimately using all the gas procurable at the large installation at the Saltley plant. On Sept. 29, 1927, according to a paper read before the Institution of Civil Engineers on Feb. 7 by F. C. Vokes and C. B. Townend (abstracted in London *Engineering*, Feb. 10, 1928), the larger plant was put in use. Gas is collected from the digestion tanks by means of floating reinforced-concrete collectors and conveyed to a 150-brake-horsepower engine, which drives a 100-kw., 4,000-volt alternator. Each collector is in the form of a "raft," 10x20 ft. in plan, with vertical sides "extending 2 ft. above the raft and 2 ft. below, forming two open compartments, the lower for the collection of gas and the upper" for displacement. Gas is drawn off from "a pyramid formed on the center of the raft." The collectors are connected in three blocks of 48 each, and the whole 144 are estimated to make available 16,000,000 cu.ft. of gas a year, with a calorific value of 625 B.t.u., at an estimated production cost of 7½d. [15c.] per M. The engineer's abstract states that the "estimated production cost of current is 0.49d. (1c.) per unit, effecting a net saving of more than £1,000 [about $4,900] per annum for the first unit."

Sliding Forms Build Double Walls at High Speed

Four Six-Story Walls Concreted in 12½ Days, Using 800 Ft. of Forms Rising 4 In. an Hour and Exposing Concrete in Nine Hours

SPEED of pouring and exposing concrete walls in cold weather is illustrated by the cold-storage plant completed this winter at Cleveland, Ohio, for the City Fuel & Ice Company. The fast work was obtained by using sliding forms, a low-slump concrete made workable by admixture, heating the water, protecting the placed concrete and organizing the job for high speed. Briefly, about 6,500 cu.yd. of concrete was placed in double walls in 12½ working days from Nov. 3 to Nov. 21, 1927.

The building as shown at about first floor level by Fig. 1, is 200 ft. square and 94 ft. high. The walls are without windows, but the outer walls have on each front eleven 6-in. pilasters. Except for the pilasters, the outer walls, 12 in. thick, are unbroken, but the inner walls, 16 in. thick, have at each floor level, Fig. 2, slots to take the edges of the concrete floor slabs carried interiorly by columns. At floor levels also the two walls are tied together by ¾-in. rods across the 12-in. insulating space. Each wall has 18,800 sq.ft. of face and requires 2⅓ cu.ft. of concrete per face-foot.

The method employed was to place and puddle the concrete in 4-in. layers entirely around the building, using sliding forms riding on vertical rods and moving upward at a rate of approximately 4 in. an hour. The form construction is indicated by the sketch, Fig. 3, and by the view, Fig. 5, of one of the lifting yokes. Except that they are made to mold a double wall, the forms are of familiar design and structure. The features to be noted are: The forms were continuous around the building; the yokes carried outer and inner continuous runways, and inner and outer finishers' scaffolds were hung from the yokes and traveled with the forms. The moving unit, then, combined forms, runways and scaffolds—a rather substantial assemblage to be kept moving. Fig. 2 gives an idea of the appearance of the forms, and the runways can be fairly well visualized from Fig. 1.

Two crews of eight jackmen kept the forms moving. Virtually a continuous travel of 4 in. per hour was kept up. The forms were kept level and plumb by a system of spirit levels, which were carefully watched and checked at intervals by the engineers. The walls were built simultaneously in one continuous pour, which began at

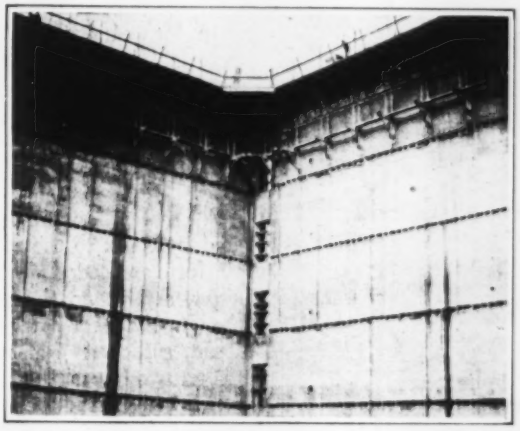


FIG. 2—INSIDE WALLS, SHOWING FORMS AND FLOOR SLOTS

3 p.m. Nov. 9 and ended at 3 a.m. Nov. 21. The actual daily progress is shown by the diagram, Fig. 3. The concrete was placed and puddled in 4-in. layers, a complete circuit requiring approximately one hour. Only a small amount of puddling was necessary, most of the spaders' effort being devoted to keeping the form faces free from hardening mortar and thus insuring a smooth surface for the finished wall.

As the concrete was exposed within nine hours after it was poured, the operation of removing form marks was a simple one performed by one man on each side of the wall, each man being equipped with a bucket of water and a whitewash brush. No patching whatever was necessary on the 150,000 sq.ft. of exposed wall surface, although on the outer wall fronts there are 44 6-in. pilasters with 3-in. radius corners. The floor slots were molded by setting slot forms, Fig. 4, as the proper levels were reached. It will be understood that the slid-

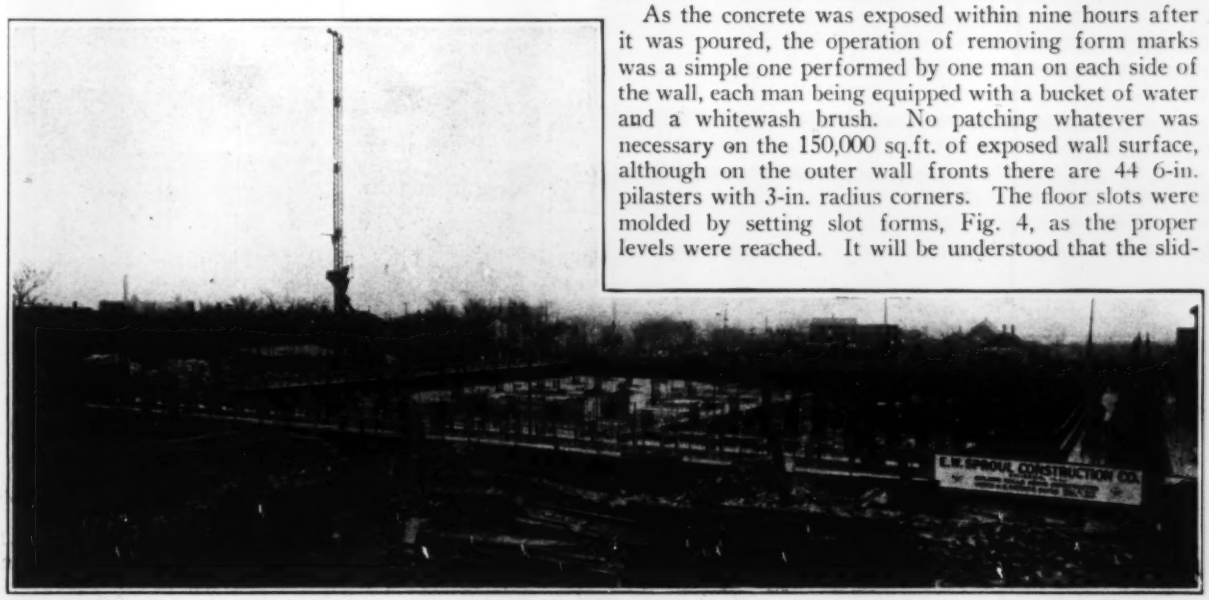


FIG. 1—START OF WALL CONSTRUCTION WITH SLIDING FORMS ON COLD-STORAGE BUILDING AT CLEVELAND

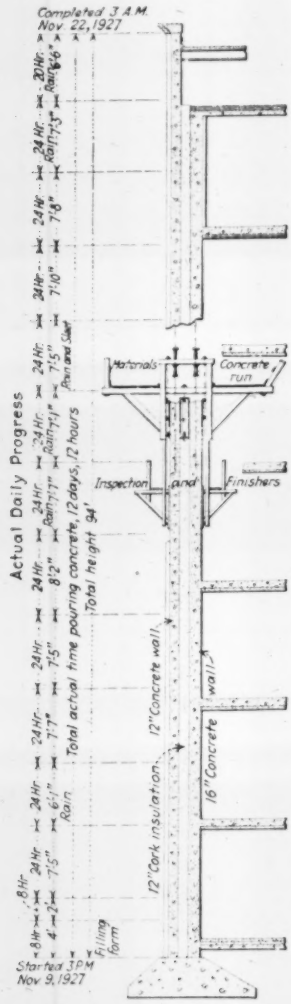


FIG. 3—DAILY PROGRESS CHART OF WALL CONCRETING, SHOWING FORMS

ing forms traveled over these slot forms and over the anchor rods tying together the double walls at each floor level.

Fig. 7 shows the plant layout. This was simple. The mast, which handled both the concrete hoisting bucket and the platform for elevating the other materials, was set back far enough to clear the structure. The boiler for water heating and the shed for housing the electric hoist were located just off the materials platform. The measuring hopper and a limited amount of cement and diatomaceous silica were protected by an open shed.

All materials were delivered by truck to the mixer platform as needed, day and night, and at no time was the supply of sand and stone sufficient for more than a two hours' run. Ten men wheeled sand and stone to the hopper, two men handled cement and admixture, and a straw boss controlled the consistency by carefully measuring and adding water. On top, the concrete was received from the lift by a hopper which rode with the forms. Eight buggy men delivered all the concrete, each man opening the hopper gate and filling his own buggy. The pour was made in an anti-clockwise direction and each man made a complete round trip for each load of concrete delivered. The average time for a trip was three minutes; thus each buggy pusher traveled 24 miles in an eight-hour shift. Plenty of fresh air at a temperature slightly above freezing was wafted to the buggy pushers from Lake Erie and served to keep them interested in continued activity.

The mix consisted of one part portland cement, two parts of clean sharp sand, four parts of $\frac{3}{4}$-in. washed limestone and 3 lb. of diatomaceous silica per bag of cement. Because of the cold weather the water was heated. It was sparingly added in an effort to produce a consistency sufficiently workable to be handled readily, yet so stiff that the concrete would remain in place upon being exposed nine hours later. With the admixture this was easily accomplished. According to the reports of the testing laboratory, the slump was about $1\frac{1}{2}$ in. The average three-day strengths were 688 lb. per sq.in., whereas

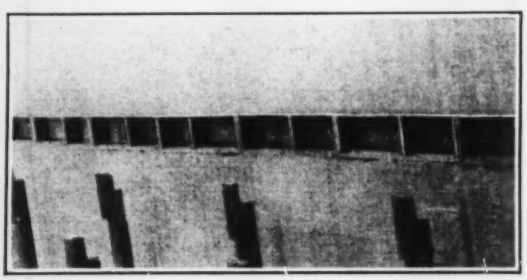


FIG. 4—FORMS FOR WALL SLOT FOR FLOOR SLAB

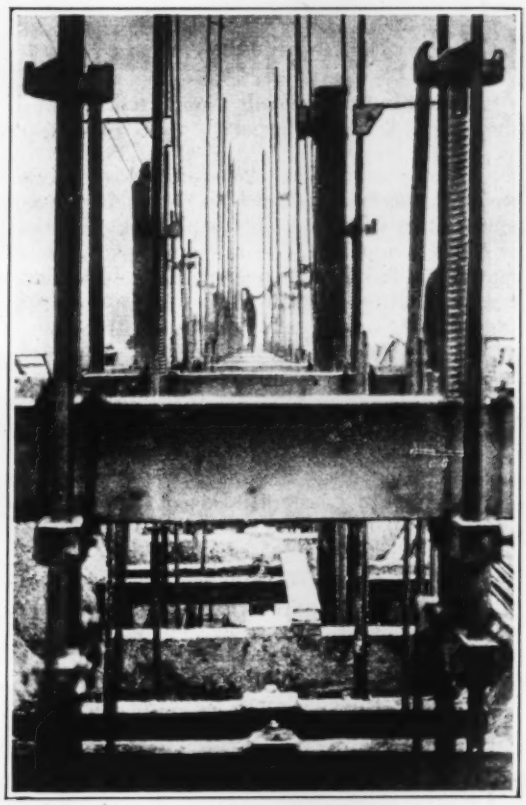


FIG. 5—VIEW OF YOKE FOR HOISTING FORMS

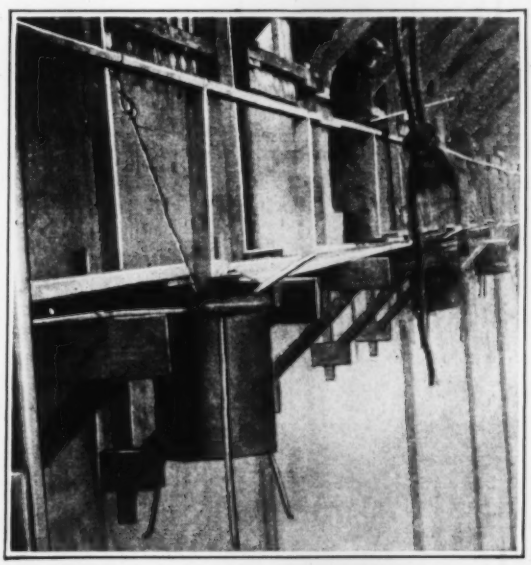


FIG. 6—SALAMANDERS HUNG FROM FINISHERS' SCAFFOLDS

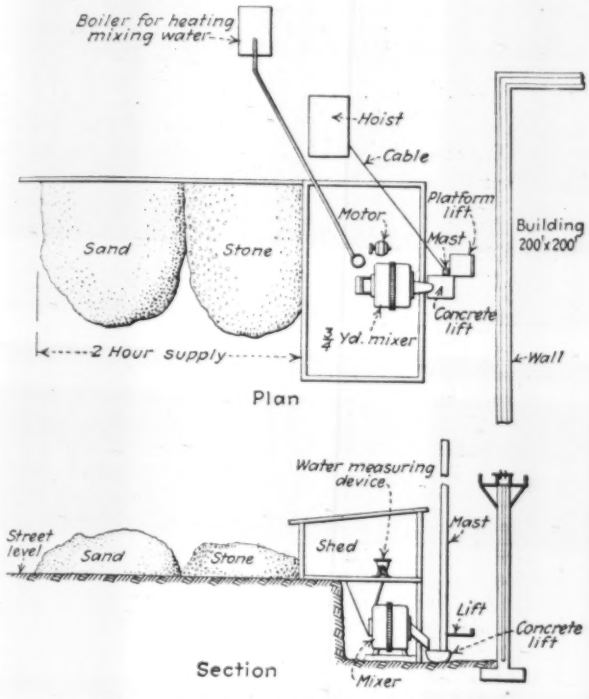


FIG. 7—SKETCH PLAN OF MIXING AND HOISTING PLANT

the 28-day tests ran well over 3,000 lb. per square inch.

In freezing weather tarpaulins were used to protect the concrete until it could set. These were hung from the top to the bottom of the forms and additional heat was supplied by means of salamanders suspended from the finishers' scaffold, Fig. 6.

The Blome Sinek Company, of Chicago, had the general contract. The E. W. Sproul Construction Company, of Chicago, was the sub-contractor for the wall construction. The Ball Ice Machine Company, of St. Louis, Mo., designed the structure.

Over 12,000,000 Developed Horsepower From Water in U. S.

The developed water power in the United States on Jan. 1, 1928, was 12,296,000 hp., showing an increase of 575,000 hp., or approximately 5 per cent, during 1927; and the total amount of potential water power available 90 per cent of the time is 38,110,000 hp. and that available 50 per cent of the time is 59,166,000 hp., according to an announcement by the Geological Survey. The figures for potential water power are not directly comparable with the figures for developed water power, because the figures for developed power are given in terms of the capacity of the installed waterwheels, which may be several times the potential power available 90 per cent of the time. Estimates based on studies of the capacity of waterwheels installed at fully developed water-power sites indicate that about 15 per cent of the potential water power of the United States is developed at the present time. If it were feasible to develop all the water-power resources of the United States, the total capacity of waterwheels installed at all water-power plants would amount to about 85,000,000 hp.

All of the increase in developed water power in 1927 was in the plants of public utility power companies, the capacity of waterwheels in manufacturing plants showing a small decrease during the year. California still ranks first in developed water power, with a total of 1,993,000 hp. of waterwheels in water-power plants. New York, with 1,779,000 hp., is second, and Washington, with 707,000 hp., is third.

The estimate of potential water power in the United States has been revised to include the results of recent studies and surveys, particularly in the upper Columbia River basin and the Tennessee River basin. Washington, with 11,200,000 hp. available 50 per cent of the time, leads all the states in water-power resources by a wide margin. It is followed by California with 6,700,000 hp., Oregon with 5,900,000 hp., and New York with 5,000,000 hp., these figures representing power available 50 per cent of the time at an efficiency of 70 per cent. Most of the undeveloped power in New York is on the Niagara and St. Lawrence rivers.

Double Chlorination of Water at Quincy, Ill.

TWELVE months' experience with double chlorination of the water supply of Quincy, Ill., ended with December, 1927, has been generally satisfactory except during three months of warm weather. Double coagulation has also been employed with satisfaction since 1914. Particulars as to pre-clorination and its results have been furnished *Engineering News-Record* by W. R. Gelston, superintendent of water-works.

The pre-chlorination dose is introduced at the same point as is the first dose of sulphate of alumina, as the raw water enters the mixing chamber, which is of the over- and under-baffle type. The water then passes to the first sedimentation basin, which gives a theoretical subsidence period of 1½ hours. The second dose of alum is applied as the water enters the second mixing chamber, and the subsidence period in the second sedimentation basin is three hours. The filtered water goes to a clear-water basin of 0.15 m.g. capacity under the filters, and thence to a 1-m.g. storage reservoir and the main pumps. Pre-chlorination has eliminated short filter runs and has increased the amount of water delivered per filter wash.

Bacterial results were excellent until June, 1927, with the bacteria in the settled water before filtration usually below 100 per cubic centimeter. About June 20 the temperature of the river water had reached 73.4 deg. F., and the turbidity was low. Instead of a reduction in total bacteria being obtained through the coagulation, sedimentation and filtration, the count increased greatly. The final dose of chlorine cut down the total count to what was considered a satisfactory number. The filtered water contained very few B. coli, whereas in the years preceding pre-chlorination B. coli in the filter effluent were quite common. After Sept. 20, when the temperature of the river water was again below 60 deg. F., the turbidity of the water increased and results were again excellent.

While a positive explanation of the bacterial increase between pre-chlorination and post-chlorination cannot be given, it is considered as probably due to the killing of algæ in the water, thereby furnishing ample food for the rapid increase in the number of those bacteria not killed by the pre-chlorination treatment. This condition would be similar to well-known increases in the number of bacteria in reservoirs after treatment with copper sulphate for the reduction of algæ growths.

Better Concrete Construction and Testing—A.C.I. Meeting at Philadelphia

Workability of Concrete and Permanence of Construction Discussed—A New Concrete Building Code—Architectural Possibilities—Talbot and Lord Receive Medal Awards

CONTINUED growth both in membership and in strength of purpose was evidenced by the American Concrete Institute in its 24th annual convention, held last week at Philadelphia. Nearly every phase of concrete construction and use was included in the proceedings of the eight sessions which constituted the meeting, but some individual subjects stood out prominently, among them workability, a concrete building code, together with an elaborate compilation of design and cost data, and a new view of the design of skew arches.

About 650 attended the meeting, an attendance representing about one-fourth of the numerical strength of the society and exceeding that registered at any prior meeting. The interest brought to bear on the technical sessions was correspondingly active. Further, this gathering of the clans was utilized by a number of committees of other societies and by various industrial organizations, which scheduled their meetings at Philadelphia during the convention week.

Lord and Talbot Awarded Medals

Special recognition was given to excellence in technical achievement by the award of two medals. The first award of the Henry C. Turner medal for notable achievement in the concrete industry, instituted a year ago, was made to Prof. Arthur N. Talbot, of the University of Illinois, in recognition of his extensive contribution to the concrete art through research. Arthur C. Lord received the Wason medal for the most meritorious paper of the 1927 convention, "Notes on Concrete, Wacker Drive, Chicago."

M. M. Upson, president of the Institute, was succeeded by Edward D. Boyer, long prominent in its councils. D. A. Abrams was re-elected vice-president, and S. C. Hollister was appointed to fill the vice-presidency vacated by Mr. Boyer. One director joined the board, J. C. Pearson, appointed to fill the place vacated by Mr. Hollister. Harvey Whipple was continued in the offices of secretary and treasurer.

Mr. Upson, before resigning the chair to Mr. Boyer, made special commemoration of the death of Frank C. Wight, editor of *Engineering News-Record,* and paid tribute to Mr. Wight's service to the Institute as counselor and guide.

A new field of work that is likely to be entered upon by the society is that of formulating specifications for cast stone. A committee on specifications for concrete building units has long been in existence, but the present subject is of distinctly different character. It received much discussion at the meeting and led to a vote recommending to the board the appointment of a committee on specifications. There is also a possibility that the society will revive a former committee on contractor's plant in order to bring this subject up to date and serve modern needs for precise information.

While the extensive technical program of the convention cannot be reviewed in detail here, some of its prominent features are summarized.

A group of six papers dealt with various aspects of the ever more active question of what "workability" means and how it shall be measured. Since the spreading of the doctrine that the amount of water in the mix ought not to exceed a fairly low percentage and that the concrete at the same time must be so proportioned and mixed as to be easily workable and placeable, many attempts have been made to correlate these qualities with consistency, or else to distinguish it therefrom, and to develop a quantitative measure of the property sought for.

What Is Workability?

Experimental studies carried on at the Bureau of Standards by George A. Smith and George Conahey, working in the interests of the diatomaceous admixture material Celite, led the experimenters to construct a penetration device in which three rods are forced into the mixed concrete by a miniature pile-driver device; the total energy of fall required to give a certain penetration is called the "workability figure" and is assumed to be inversely related to workability. With increase of softness (wetness) of mixture this figure first decreases and then increases. Some of the results appeared to indicate that admixture of diatomaceous earth gives a low workability figure in an economical manner.

Other factors of the problem were discussed in a report of P. H. Bates, of the regular staff of the Bureau of Standards, on a wide range of tests using different methods of deforming or causing flow of cement pastes (extrusion, a ball plasticimeter test, and capillary flow) as indicators of plasticity or viscosity. These methods, applied to a variety of cements, revealed large differences among the several cements. As the author expressed it, the present-day situation is that "cements, like men, are not all born equal, and most of us are engaged in trying to find out their differences."

Various practical aspects of easy workability of concrete were outlined by A. T. Goldbeck, of the National Crushed Stone Association; R. L. Bertin, of the White Construction Company; R. W. Atwater, structural engineer of McClellan & Junkersfeld, and Nelson L. Doe, of the Turner Construction Company. Mr. Doe, under the title "What Workability Means to the Contractor," pointed out that a mix deficient in workability can be improved by (1) adding cement and water, (2) changing aggregates or (3) using an admixture. The second is in general the most attractive possibility to the contractor but is not always easy to utilize, whereas the first method is best and involves usually but little increase of cost. An important point is that often two aggregates equal in price will show large differences in the cement factor for workability; this point was illustrated by comparison of two New York sands both by analysis and by results on two comparable jobs. In any event, to maintain proper workability in regular operation requires either installation of a control system of elaborate measuring devices and careful check of variations, or else increase of cement to give a margin sufficient to cover the run of

variations in aggregates and measurement; the latter may often prove the cheaper way. Workability also has much bearing on methods of transporting the mixed concrete, especially when buggies or belts are used; the latter, he predicted, are going to be used much more than they have been used. Bottom-dumping equipment is least susceptible to workability variations and produces much re-mixing.

J. G. Ahlers, of the Barney-Ahlers Company, emphasized the effect of the quality of the slurry on workability, and mentioned the value of prehydration in producing a stable slurry. L. C. Wason, of the Aberthaw Construction Company, mentioned the under-sanding of conventional mixes (the common 1:2:4 mix should be made about 1:2.4:3.6) as detrimental to workability. Cloyd M. Chapman and others questioned the argument of Smith and Conahey, Mr. Chapman doubting whether they measured the quality that workmen and foremen want. J. C. Pearson, of the Lehigh Portland Cement Company, called for development of more fundamental methods of measuring workability, which is probably related to rate of shear; possibly power measurements on mixers might be significant. P. H. Bates stated that strength has been overemphasized and that serviceability of concrete should be the objective. Prof. A. N. Talbot queried the sensitiveness of penetrometer tests for measuring differences in flow rate. As to power measurements, tests which he made some years ago did not prove promising, and attempts to measure deformation resistance of concrete placed in a rubber tube also failed.

Building Regulations for Reinforced Concrete

An important document was laid before the meeting by its committee on building regulations—namely, a set of regulations covering reinforced-concrete design and construction suitable for direct incorporation in building codes. This code was prepared in co-operation with a committee of the Concrete Reinforcing Steel Institute, and thus represents the joint effort of the leading organizations in the concrete field.

The present draft follows prior work on the subject. In 1925 a code was reported; it was revised slightly and again reported in 1927, when it was adopted by the A.C.I. as a tentative standard. But it then appeared that the Reinforcing Steel Institute had a distinctly different code under consideration and that an effort to harmonize the differences might be worth while. The present code is the result of such effort, and has been agreed to by the committees of both societies. Besides harmonizing divergent views, it also takes account of recent advances in concrete practice.

Among the essential innovations are: Increase of the tensile stress in the main reinforcement (if of intermediate or rail-steel grades) from 18,000 to 20,000 and decrease of stress in web reinforcement to 16,000 lb. per sq.in.; removal of discrimination against rail steel; increase in stress on structural steel from 16,000 to 18,000; provision for concrete stronger than 3,000 lb. when very rigid control is assured; reduction of maximum shear in concrete by one-fourth, to 0.09 of the crushing strength of the concrete, except that the 0.12 figure may still be used under special conditions.

Presentation and discussion of the report took up most of a long session, continuing well past midnight, during which the chairman of the committee, F. R. McMillan, carried the major burden. The committee itself brought in a large number of last-minute revisions of detail, which were discussed extensively and in the main accepted by the meeting. One interesting change was the more precise differentiation of "composite" and "combination" columns, two types in which there is a steel or cast-iron core designed to carry part of the load. The composite column must have spiral and longitudinal reinforcement; the combination column a steel core capable of carrying all dead loads, wrapped with wire at 4-in. spacing and incased in 2,000-lb. concrete 2 in. thick over metal except rivet heads and connections. Another change was made in the field tests of concrete, which now are to include a set of specimens cured in the laboratory (as control on quality of mix) and another set cured in the field (as control on curing).

Further changes were proposed from the floor, and of these some were accepted by both committee and meeting, whereas others were referred to the committe for further study during the coming year. Finally the code as a whole was approved by the meeting as a tentative standard, for practical discussion and criticism and for study of some remaining points of question by the committee. As there was no disagreement on any major element of the code, it will probably be advanced to standard at next year's meeting.

A remarkable paper closely related to this code was a voluminous compilation by Arthur R. Lord, "Design and Cost Data for the 1928 Joint Standard Building Code." Most of this paper consists of tables and diagrams for proportioning beams, columns, slabs and footings, using the working stresses and other limiting factors specified in the committee code and using only the simplified-practice sizes of reinforcing bar. Appended to this are some tables giving concrete quantities and costs for a full-height interior panel of a building for several different heights of building, panel size, concrete strength, load, etc. Since a great part of the paper was computed and drawn specially for the purpose, it represents a vast amount of labor.

The Architect and Concrete

Three problems of the architectural utilization of concrete were discussed in an interesting evening session—namely, decorative painting, special types of vaulted framing in reinforced concrete, and wall construction and ornamentation.

Sidney F. Ross, of Arnold W. Brunner Associates, described two recent instances of decorative painting on concrete, a mess hall at West Point and an auditorium in Brooklyn, the former a dense stone concrete, the latter cinder concrete. On the cinder concrete an undercoat of cellulose lacquer paint and top coats of lead and oil were used with success. On the stone concrete aluminum was used in the forming to produce a porous surface, on which cellulose acetate paint could then be applied. Nathan C. Johnson, who had been adviser in these cases, pointed out in discussion that climate and moisture conditions control the choice of paints and methods; in Los Angeles decorative paints can be applied direct even to outside walls.

E. Praeger, of B. G. Goodhue Associates, described the arch-like frame of the Church of the Heavenly Rest, New York; the vault framing of the Los Angeles Public Library; a Japanese form of roof for Dillingham Hall, Hawaii; and several other recent examples of difficult building framing worked out by aid of reinforced concrete. Arthur J. Meigs, of Philadelphia, then showed a

series of views of an artistic country home and a college auditorium using natural-surfaced concrete most attractively. Finally, W. E. Hart, of the Portland Cement Association, discussed various phases of concrete wall construction and showed a large number of views, mainly of southern California buildings, illustrating decorative wall development.

Improvement of concrete quality, though it was indirectly the theme of most of the convention program, was more specifically at issue in two papers. One of these was stimulative and challenging, the other instructional in character. The latter, "Concrete Primer," by F. R. McMillan, of the Portland Cement Association, who also played a large part in preparing the building code noted previously, consisted of a catechism on cement and concrete, written in gratifyingly simple style and yet expressing precisely the best knowledge of today. The Primer not only is adapted to the needs of the beginner but can help to clarify the thought of men practically concerned with concrete; also, according to the author's foreword, it has a special mission in convincing executives "that good concrete can be had, that it should be had, and . . . that it must be had . . . and had economically."

Better Concrete

Approaching the subject from another side, Nathan C. Johnson addressed the convention on "Better Concrete—Do We Mean It?" His paper was in effect a call for action in research and practical method and their correlation, to produce better concrete. Some random notes on the paper may be set down as follows:

The concrete-using industries in the United States represent an annual value of about two billion dollars. It should be possible to extend the scope of this activity greatly, perhaps double it. There are extensive opportunities, for there is no structural material that cannot be replaced to advantage by concrete provided we are alert and not self-satisfied as to what has been achieved in the past. Yet we find an architect describing his "concrete building" as having an exterior of stone, an interior of gypsum, roof and floors of tile, all of which need not be if the possibilities of concrete are fully realized. We can utilize the properties of concrete immeasurably better than we do. But this requires new thought, in particular a departure from the worship of stress; strength per square inch is better forgotten than exalted as it is today. Never was there a more opportune time than the present for new thought in this field. If the opportunity is taken, in five years we shall not know the present-day concrete industry. By a little refinement of method we can produce concrete that not merely will be strong but will meet any purpose of serviceability.

Mr. Johnson amplified these statements by photographic views showing common faults of concrete, the water absorption of concrete in sea water at each rise of the tide as revealed by measurements of electrical conductivity, the "X-ray study" of the inner structure of concrete made possible by stripping the surface skin of cement, and various other features of the present status of the concrete art.

A number of discussions gave support to Mr. Johnson's demand for improvement in concrete. A new note was introduced by W. J. Barney, of the Barney-Ahlers Company, who, after charging architects with neglect of the industrial building, suggested the organization of an architectural committee to bring out the possibilities of beauty in concrete. On the subject of quality more specifically, R. W. Atwater quoted P. H. Bates to the effect that the real objective in concrete production is serviceability and not strength, and said that we ought to be able to predict and predetermine other qualities as we do strength.

Skew Arch Construction

Ninth St. Bridge, over Chester River at Chester, Pa., is a structure of 160-ft. span, 12.6-ft. rise, 60-ft. width and 42 deg. skew, completed in October, 1926, according to designs of S. C. Hollister, of Philadelphia. Its highly original design and construction were described for the first time by Mr. Hollister at the present convention. The exceptional nature of the bridge is indicated by the fact that no part of either abutment face is perpendicularly opposite the other.

Prior to the design a theory of analysis was worked out. This indicated large torsional moments in the arch barrel, and with a view to providing corresponding resistance the barrel was designed as a double sheet, one above the other, connected by the spandrel walls and four interior walls. The gross depth of this box construction is 10 ft. at the haunches, but only 4 ft. 3 in. at midspan, because of the low height of roadway level. This low center depth available was, in fact, a prime reason for the adoption of the form of structure used, since it would in any event require the middle third of the span to have the roadway integral with the arch and therefore prevented the use of an open-spandrel rib arch, in which the skew effects could have been avoided or minimized.

Construction of the bridge was complicated by unfavorable foundation conditions at the east abutment, where the rock dipped away from the river. Here the abutment was anchored into the rock by inclined and vertical dowels to provide both tension and shear bond. Another special problem arose in the centering, the pile supports of which could not be braced laterally and might thus be overturned by lateral thrusts due to skew action of the arch in settling. The arch barrel was therefore poured in voussoirs separated by key sections poured last.

Corresponding to the torsion in the arch, the reinforcement in the arch barrel is mainly transverse. The tension at the abutment at the acute angle of the arch was specially provided for, and the acute angle of the abutment was designed for the excess thrust developed here. Extensometer measurements made at nine points of the arch during construction and afterward verified the existence of the tension and also showed that temperature variations produced high stresses.

A paper of somewhat analogous novelty was presented by Prof. J. A. Wise, of the University of Minnesota, under the title "The Calculation of Flat Plates by the Elastic Web Method." It gave a simple presentation of a method of slab analysis worked out by H. Marcus, of Breslau, Germany.

Studies of Crazing—Experimental study of crazing of mortars (stuccos) has been in progress at the Bureau of Standards for two years. It was reviewed by P. H. Bates and C. H. Jumper, of the bureau. Glass, rubber and mortar surfaces were used as bases. The results up to now are heterogeneous. The same subject was dealt with by A. H. White, V. A. Aagard and A. O. L. Christensen, of the University of Michigan, who reported the length-change curves of a number of bars of neat cement

and concrete 4 in. long *during a period of eighteen years* involving repeated wetting and drying. These, with shorter tests, lead the authors to state that crazing is caused by shrinkage of a cement surface which is drying faster than the main body of the concrete; that a lean mixture is advantageous because it contains less colloidal cement to cause shrinkage; and that rich mixtures may be helped by water-repellant integral admixtures or by protective coatings.

Rather long discussion followed, with two special items: Prof. R. E. Davis reported tests of brick mortars cast in waterproof molds, in terra cotta molds and in brick piers, which showed decreasing shrinkage in the order named, with expansion, so far, in the last-mentioned specimens. C. M. Chapman laid emphasis on the influence of the aggregates on shrinkage, stating that some aggregates make the shrinkage six times as great as others.

Flow of Concrete—Concrete specimens held under steady compressive stress by car springs have been for two years under test to measure flow, as reported in a paper by Prof. Raymond E. Davis, of the University of California. Loadings of 200 to 1,200 lb. per sq.in. are used. Except for some specimens kept in water spray, all are still shortening, and a flow of 0.10 per cent has been reached by some. The flow is greatest for lean mixes, low fineness modulus, air exposure, low modulus of elasticity and early beginning of loading. In all cases the most rapid flow occurs during the first few days, after which the curve flattens rapidly.

A general confirmation of Professor Davis' results was reported by Prof. J. R. Shank, of Ohio State University.

Blocks and Stone—Building units and cast stone received much attention, two sessions of the eight being devoted to them. On roofing tile, stucco and stone, papers by L. H. Allen, of the Hawthorne Roofing Tile Company; G. J. Eyrick, Jr., of Smith, Hinchman & Grylls; C. Van de Bogart, of the Economy Concrete Company; M. A. Arnold, of the Arnold Stone, Brick & Tile Company; Gilbert E. Tucker, of the Pacific Stone Company; and W. S. Steele, of the Mohawk Stucco Company, emphasized the need for improved knowledge, technical specifications and commercial standards to bring about high quality and permit satisfactory service to users to be maintained. From these papers arose the proposal that the society establish a committee on specifications for cast stone, as already mentioned. Such problems as permanence of color and control of efflorescence in roofing tile represent the need for further technical research.

In the field of block and brick there were papers by D. R. Collins, R. W. Scheer, of the Best Block Company, and L. E. Grube, the latter outlining a special drying system for brick used at Sheboygan. An interesting phase of this industry is that light-weight aggregate, of the Haydite type, is coming into wide use in the block field.

Other technical papers that were presented with little or no discussion included:

"A Method for Predicting Concrete Strength With Increased Precision," by Prof. H. J. Gilkey, of the University of Colorado, which set forth the possibility of strength prediction for any particular age, water ratio, mixing time and curing conditions by combining the values taken from ratio curves of the influence of the separate factors;

"Study of a Method for Testing Concrete in the Field," by C. A. Wiepking, testing engineer of the Milwaukee public works department, which dealt with the beam test and showed that a beam 4x6x24 in. (as against the common 6x8x30-in. size) is satisfactory if the aggregate does not exceed 1½ in.;

"Some Suggestions From the Results of the Stevenson Creek Arch Dam Investigation," by W. A. Slater, of the Bureau of Standards;

"The Carrying Capacity of Semicircular Hooks," by Prof. T. D. Mylrea, of Carnegie Institute of Technology, which showed from tests that anchorage bends or hooks at the ends of reinforcing bars are more effective the larger the diameter of the hook, 12*d* being a satisfactory size, and are aided by a surrounding spiral hooping;

"Experience With a Strength-Specification Contract," by R. C. Johnson, of the Immel Construction Company, which gave the details of a large contract wherein the owner obtained high-strength concrete at less cost than under specified-mixture requirements, but also showed that the desired result came about only through co-operation; and

"Heavy-Duty Concrete Floors," by Charles E. Covell, of the Austin Company, which summarized extensive experience results.

Committee Reports—Aside from the important work on a concrete building code, already mentioned, the committee work reported included progress reports on aggregates, on building units, on roads and pavements and on research.

In the field of aggregates, gravels are being studied further, and the Deval-type test for abrasion is being modified, with four gradings as basis; the existing purchase specification is to be revised. An exhaustive summary of research work in progress at various cement and concrete laboratories, together with an index of articles published last year, was submitted by the research committee. Most of the work in progress is concerned with plain concrete.

State to Control Sanitary Plans in Indiana

Under a new rule of the Indiana State Board of Health, which will go into effect in April, all plans for such sanitary improvements as water-works, sewerage systems, sewage-works and garbage disposal plants must be submitted for approval of the water and sewage department of the board. This supervision, which applies only to the efficiency or adequacy of the designs, is intended principally for the protection of the smaller communities, the officials of which do not always realize the necessity of competent engineering work in the design of such plants. This step, under the powers of the health law, has not been taken in the past on account of inadequate staff, but by the aid of the Rockefeller Foundation the department is now adding to its force a chemist, a sanitary engineer and additional stenographic help. L. S. Finch, Indianapolis, is director of the Water and Sewage Department. Funds contributed to the State Board of Health by the International Health Board will be used also for carrying on extensive stream pollution investigations. The survey of the Wabash River is to be made in co-operation with the Illinois State Board of Health, while the St. Joseph River survey will be in conjunction with the Michigan State Board of Health. This policy of stream improvement not only will include the promotion of new treatment works but will of necessity call for the placing of existing plants upon an efficient operating basis.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Track Shifting Machine

ON THE construction of the Shannon hydro-electric plant in Ireland, as described in *The Engineer*, London, of Dec. 16, a track shifting machine is used. It consists of a pair of trusses supported at each end on a four-wheel truck, and having at mid-span a transverse frame carrying apparatus for raising the rails and shifting them laterally. With this machine spotted over the place where shifting is to begin, a pair of grooved wheels is made to grip each rail and hand gear then raises the rails and traverses them the desired amount, making a kink in the track. Locomotives then haul the machine forward, the grooved wheels forcing the rails and ties laterally to the new position, the wheels being cooled by streams of water. This machine works on construction tracks of 36-in. gage.

Paver and Conveyor Form Useful Portable Concreting Plant

AN INGENIOUS arrangement of a concrete road paver and a portable belt conveyor was used in California recently for placing concrete on the Los Angeles County Flood-Control District work in the Verdugo Wash. Approximately 45 tons of material was poured per hour, using only the two pieces of equipment.

In doing the work the floor of a concrete-lined channel, 3,400 ft. long and 47½ ft. wide, was first laid, using a 27-E paver. As the work progressed reinforcement was placed and the forms set in position for the 8-ft. perpendicular side walls. After the floor was finished, a portable conveyor was hooked up to the paver and a large hopper was installed at the lower end of the conveyor. The concrete from the mixer was discharged directly into this hopper, thence into the wall forms by means of the conveyor. This arrangement worked steadily at maximum capacity without trouble and eliminated the need for wheelbarrows, carts, chutes, hoists and other equipment often used on jobs of this sort. The conveyor was trailed by the paver in a charging position, and the combination of paver and conveyor was thus converted into an easily controlled mixing and delivering plant.

PAVER AND CONVEYOR CONCRETING CHANNEL SIDE WALLS

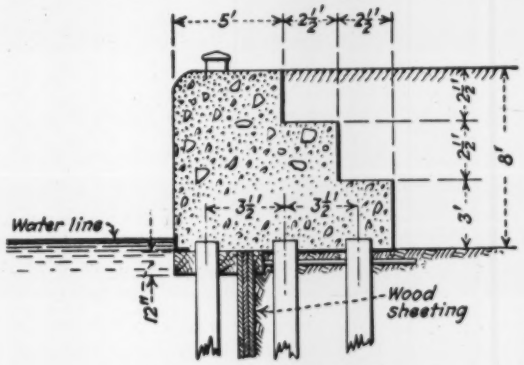
The flood-control work for the Verdugo Wash was designed under the direction of E. C. Eaton, chief engineer, and S. M. Fisher, designing engineer. The Roche Axman Company was the contractor.

The material from which this article was written was supplied by the Foote Company, Nunda, N. Y., whose paver was used in this work.

Early-Strength Concrete Made With Ordinary Cement

By Walter Cahill
Vice-President, Great Lakes Dredge & Dock Co., Chicago

IN BUILDING the dock wall of the new harbor at Buffington, Ind., concrete of high early strength was obtained with ordinary cement by means of rigid control of the water-cement strength relation, combined with the use of a rich mix. This concrete gave the following advantages: Ability to strip the forms in less than 24 hours; use of the dock wall by large steamers within five days after pouring, great ultimate strength and density; any desired degree of workability, and a saving in aggregates that helped to balance the slight additional cost. There were about 4,330 cu.yd. of concrete in this wall, the design of which is shown in the accompanying drawing. The general construction features of the harbor were described in *Engineering News-Record*, July 21, 1927, p. 101.



SECTION OF DOCK WALL

Our average compressive strength was 2,500 lb. per square inch at three days, 3,700 lb. at seven days and more than 5,200 lb. at 28 days. This high early strength made it possible each morning to strip the forms from the work placed the previous day, thus reducing the number of forms required. Our steel forms could be used nine times. While concrete of any desired workability can be secured with the methods used, we purposely made

it as stiff as possible. Proper spading eliminated voids and air pockets.

To obtain these results, the water-cement ratio was carefully maintained, with water cut to the minimum, the rule being a little less than 6 gal. to a sack of cement. Frequent laboratory tests gave the moisture content of the aggregates, allowance for which was made in measuring the water. This constant ratio between water and cement made it unnecessary to pay much attention to the mix, except to make it as workable as desired. With 6.84 sacks of cement per cubic yard, the mix was approximately 1 : 1½ : 3. The mixing time was about two minutes. All the materials were such as we use ordinarily.

Auxiliary Blade on Road Grader Makes "Single Trip Outfit"

AN AUXILIARY blade attachment to an ordinary road grader outfit has been used extensively on the California state highway system and is found convenient for scraping off and smoothing shoulders, particularly along pavements. The advantage claimed is that on comparatively light work the operation of grading the shoulder and also that of smoothing off the graded material can be completed in one trip of the machine.

The twofold purpose is accomplished by attaching the second or auxiliary blade at a suitable angle behind the main cutting blade of the outfit, the auxiliary blade not

AUXILIARY BLADE ATTACHED JUST BACK OF SCRAPER BLADE

being intended to do any cutting but rather to spread and level off the windrow graded up by the cutter blade. Several types of this device have been tried out experimentally on different parts of the state highway system. In some types the second blade is more or less easily adjusted on the job by levers or by changing bolts that fasten it in place. In one type the blade hangs freely, its elevation being regulated by the contour of the surface scraped.

The type shown in the accompanying side view was developed by O. F. Georges, district maintenance superintendent, State Division of Highways, and consists of two parts. The first 2 or 3 ft. of the blade is made as high as the main cutting blade, and the remainder, extending to a total length of 7 or 8 ft. under the machine, is only 4 or 5 in. high. This arrangement was adopted to prevent spilling material over the top of the second blade at the point where it picks up its load, while the extension of lower height spreads the material without interference with the under parts of the gasoline motor.

REAR VIEW OF AN AUXILIARY BLADE PLACED BEHIND THE OUTFIT

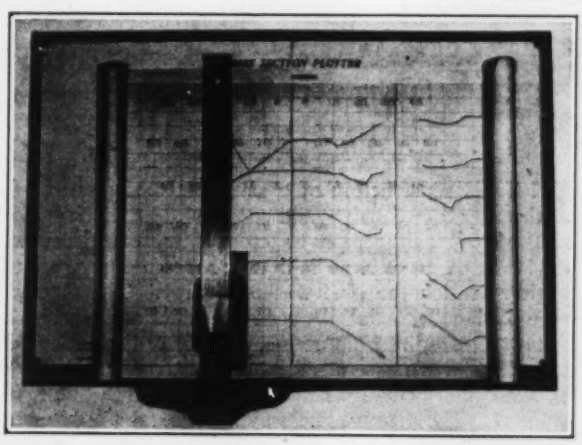
The angle at which the second blade is set is a matter of some importance, but this is either set in the shop or adjusted in the field to suit local conditions after a little intelligent attention on the part of the foreman. This attachment weighs about 50 lb. and can be made at an approximate cost of $40.

Another type having a standard mold board attached at the rear end of the grader outfit has the advantage of ample spacing between the two blades, thus avoiding any clogging of this space by thick weeds. With this arrangement the operator can adjust the height of the auxiliary blade independently of and without interference with other parts of the outfit. The arrangement shown was made from materials at hand in the maintenance yard of the department and could be brought out in lighter and simpler form.

Device for Plotting Cross-Sections From Instrument Height

IN ORDER to plot cross-sections direct from instrument heights, the device herewith pictured has been developed. It is not intended solely as a mechanical device, and best results will be obtained when it is used simply as a guide with which to find the proper location of each cross-section point on cross-section paper. Three main parts compose the section plotted:

1. The number sheet, which is so printed as to be visible through transparent cross-section paper, and gives a visible scale of distance out from the center line in each direction.
2. The T-square.
3. The slide with the rod-reading plotting scale at-



DEVICE FOR QUICK PLOTTING OF CROSS-SECTIONS

tached. (This rod-reading scale is so graduated as to plot either plus or minus readings.)

In using the section plotter, at the bottom of the cross-section column plot the computed elevation of the center line point of the first cross-section and record the station number and assumed station. Move the level rod scale up the blade of the T-square until the zero coincides with the nearest half-foot of the computed instrument height. This setting brings each graduation of the level rod-plotting scale coincident with the horizontal ruling of the cross-section paper. To check this setting compare the plotting scale intercept between the zero and the plotted center-line elevation with the recorded notebook rod reading for the same point. Make sure that this intercept reading differs from the notebook rod reading by the same amount as that wherein the half-foot setting differs from the true instrument height.

For example, given a height of instrument of 306.8, the center line rod of 2.7 with center-line elevation of 304.1. Plot the elevation 304.1. Set the zero of the plotting scale on 307 (the nearest half-foot). The scale intercept reads 2.9, which is 0.2 more than the given rod 2.7, or the amount that 307 differs from 306.8. This difference must be added to all the other rods for the section. By following these instructions one can be sure that the slide setting is correct and that one has also checked both plotting and computation of the center-line elevation. To complete plotting of the section move the T-square (with the scale slide remaining as set) to the left and plot the successive rod readings plus or minus the difference between the computed instrument height and the half-foot setting. Move the device back across the center line and plot the reading to the right. Then plot the next section by moving up the column, and when the column is completed, advance the cross-section paper of the next center line and continue. As the T-square with the slide attached is moved back and forth across the cross-section paper, it will be found that there are places where the graduations on the level rod scale do not exactly coincide with the cross-section paper ruling. However, the thing to remember is that one must plot by the paper and use the section plotter merely as a guide.

A patent has been applied for on the section plotter herein described, which is known as the Ames Section Plotter, originated by R. McCormick of Ames, Iowa. It has been used extensively in plotting cross-sections by the Iowa State Highway Commission.

Shore Assembly for Laying Subaqueous Sewer Pipe

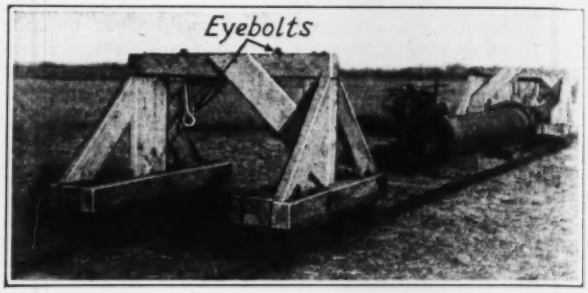
By Paul J. Jones
J. P. White Company, North Wildwood, N. J.

IN THE construction of a sewage-disposal system for the city of North Wildwood, N. J., an ingenious method of laying pipe to cross Hereford Inlet was devised. A track was laid on shore in line with the position which the pipe was to occupy. The pipe was then laid on the ties between the rails and suspended from the cars, built up of medium heavy timbers rigidly bolted. The cars were spaced on about 36-ft. centers or at such intermediate distances as to give the pipe full support. The pipe was held by eyebolts and a wire rope sling.

With this shore assembly of pipe, a trench was dredged in the bed of the inlet and the track placed therein. The pipe was pushed out into the water on the cars and when in the position which it was ultimately to occupy, the eyebolts were unscrewed and the pipe was allowed to drop into position. It was possible to salvage the cars.

From Job and Office

Hints That Cut Cost and Time

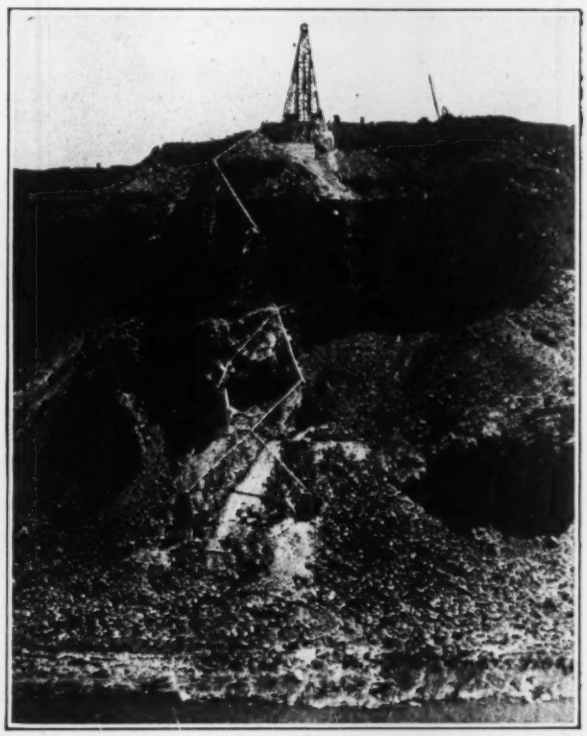


PIPE SUSPENDED FROM TIMBER FRAMES READY FOR LAUNCHING

Long Drop for Concrete Chuted to Bridge Piers

IN DELIVERING concrete to tower footings for the Twin Falls Jerome toll bridge in Idaho, the mixer plant was set up on the canyon rim and the concrete was delivered by chutes and by skips on the cableway to the tower footings in the canyon below.

The cableway spanning the canyon was used for foot-



CONCRETE DELIVERY SYSTEM FOR SNAKE RIVER BRIDGE PIERS
Concrete moved only 355 ft. horizontally in going down 416 ft.

From Job and Office

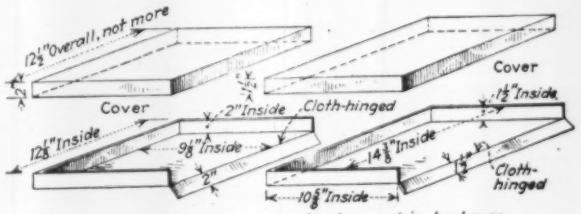
For Contractor and Engineer

ings on the opposite side of the stream, but for those on the same side as the mixing plant a series of chutes was built as shown in the accompanying illustration. To reach the lower footings by way of these chutes the concrete traveled a horizontal distance of only 355 ft. in descending to a level 416 ft. below the mixer.

Filing Copies of *Engineering News-Record*

By Samuel L. Jacobsen
New York City

IN COMMON with thousands of other subscribers to various technical publications, I have the problem of preserving copies. Even though space is available, the cost of keeping bound copies intact equals or exceeds the



FIBERBOARD FILING CASES

subscription price. After securing prices on several proposals to file these technical publications, I believe I have found a solution. The solution is embodied in the sketch shown herewith. Information from other subscribers to *Engineering News-Record* and other technical publications as to the practicability of the idea herewith pictured would be appreciated.

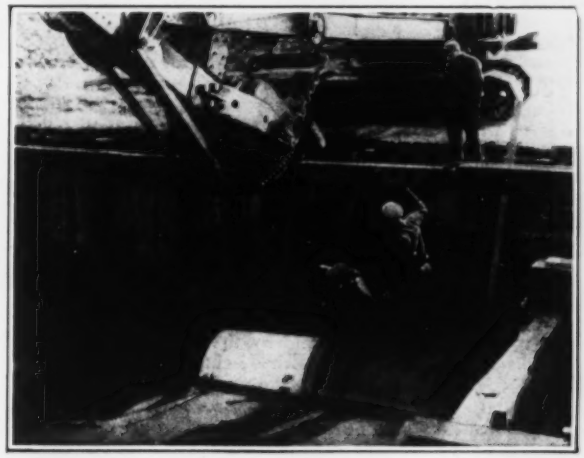
Pipe Line Laid Under Water by Ingenious Method

IN ORDER to provide a continuous supply of water to the condensers at the Ohio Public Service Company plant on the shore of Lake Erie at Lorain, Ohio, a 48-in. reinforced-concrete pipe sewer has been laid to the inlet screening house, which is about 700 ft. out in the lake. Formerly water was supplied through a 30-ft. wide channel between piers running from the screening house to the plant, but this proved inefficient, since at certain times of the year needle ice formed in the channel, interfering with the flow of water.

The method the contractor used to dig the pipe trench under water in shifting sand and to place the pipe was ingenious in that he used a power shovel with a back-digger bucket for all operations. From its position on the dock the machine dug the trench, set the pipe and backfill and drove the necessary piling. The pipe line lay about 18 ft. from the dock, which was 10 ft. high.

The operation was carried on as follows: After scooping out a hole big enough for about two lengths of pipe, the machine lowered a pipe section by means of a pipe hook, holding it in position until blocked and tamped. Two men with shoulder-high wading boots cemented the pipe on the inside at the bottom and on the outside at the top. Strips of cement bags were laid over the fresh cement to protect it from the wash of the water and from disturbance during the backfilling operation, which was carried on immediately and before the machine shifted its position.

Some piling was necessary and this was driven by the back-digger boom and bucket with a railroad tie chained

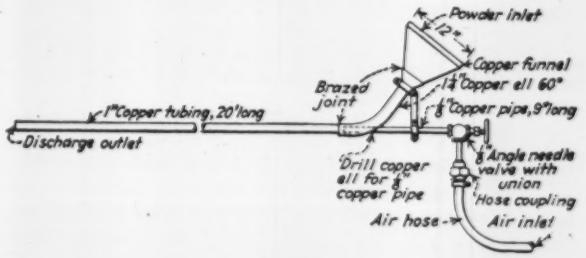


LAYING AN UNDER-WATER PIPE LINE WITH A BACK-DIGGER BUCKET

to the bottom of the bucket. Since this type of bucket may be tilted, the operator was able to control the position of the tie at all times. The job was completed in slightly less than three weeks. Trifiletti Brothers, Lorain, Ohio, were the contractors on the work, and this information was supplied by the Thew Shovel Company, whose back-digger machine was used.

Loading Blast Holes With Black Powder With Aid of Compressed Air

A DEVICE has recently been perfected by M. L. Sullivan, District VII, California Highway Commission, and superintendent of construction in charge of removal of blind curves on the Ridge Route in California, which has materially speeded up loading of



COMPRESSED-AIR POWDER LOADING DEVICE

horizontal drill holes with black powder. Referring to the accompanying sketch, powder is forced from the can into the powder inlet funnel. Compressed air furnished by a portable compressor is released through a ⅛-in. bronze needle valve and the powder is carried through the 1-in. copper tubing to the bottom of the hole. As the hole is filled with powder, the tube is gradually withdrawn. As much as 25 lb. of black powder has been placed in approximately one-half minute.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Tension on Rivets

Sir—The abstract from Prof. C. R. Young's paper on his investigation of tensile working stresses for rivets, *Engineering News-Record*, Feb. 2, 1928, p. 189, is apt to lead to the conclusion that it is proper to allow tension on rivets and that specifications forbidding such tension are needlessly restrictive.

On a job with which the writer was connected, involving heavy structural steel and moderately long rivets, the field inspector reported that a number of rivets, apparently well driven and with well-formed heads, had broken and fallen out of the holes when tested for tightness. The explanation of such failures the writer believes to be as follows:

During the process of making the field head, both it and the shop head cool rapidly, and by the time the field head is completely formed both heads have changed from a plastic to an elastic state. Since the shank of the rivet is confined in the punched hole, cooling takes place most rapidly from the heads inward, and the parts of the rivet shank nearest the heads reacquire their elastic properties while the center of the rivet shank is still in a plastic state. As the rivet contracts, the fibers of the plastic portion of the rivet are either permanently stretched or in extreme cases actually torn apart. An insufficient number of fitting-up bolts will contribute to this same condition. The longer the rivet the slower will be the rate of cooling and therefore the greater the injury to the plastic steel. The writer believes that this explains the phenomenon noticed by Professor Young that "an increase in the grip of a rivet lessens its ultimate strength."

The writer concludes that it is not wise to subject rivets to tension by external loading and that where such loading is unavoidable the allowable stress should be kept low and the inspection of driven rivets be very thorough. Professor Young is, of course, entirely correct in believing that no increase of stress on a rivet is possible until the load imposed has exceeded the initial tension in the rivet, a fact which can be demonstrated by the ordinary laws of statics.

Providence, R. I., Feb. 6, 1928. ELI M. VINER, Structural Engineer.

Sir—Referring to the subject of rivet tension considered in the article in your Feb. 2 issue by Prof. C. R. Young, University of Toronto, I should like to add some observations.

Professor Young mentions the paucity of tension values. In a letter in the same issue Harold D. Hussey calls attention to three recent specifications allowing tension on the rivets of 40 to 50 per cent of the shear value. In my book, "Steel Designing," 1913, I recommended the allowance for tension on rivet heads of 50 per cent of the shear value. While Professor Young recommends much higher units than this, there are important reasons for a low unit and in fact for the further precautions given in my book. These precautions are: (1) that a tension detail have at least four rivets, symmetrically placed with respect to the pull; (2) that in addition to the rivets needed for the tension, there be rivets enough to take the shear; and (3) that the connection be designed with thick enough metal to take the bending stresses at the heel of the angles.

It is not unusual to see heads of rivets pop off after driving, due probably to overheating or to improper steel. Fortunately, the lack of heads on rivets does not constitute a very serious menace when only shearing and bearing strength is needed. But tension at high unit values on such heads would mean disaster.

Professor Young demonstrated that the tension on a rivet, already in tension due to shrinkage, is not increased when additional tension is applied to the connection, until the original tension is exceeded. When I made that statement in the columns of your paper a number of years ago, it brought out somewhat of a storm of criticism.

Pittsburgh, Pa., Feb. 6, 1928. EDWARD GODFREY, Structural Engineer.

Some Essentials for Thin Dams

Sir—Several years ago the writer scraped half an ounce of white efflorescence from the under surface of a thin concrete shell against the upper surface of which was water under a head of 40 or 50 ft., for the purpose of having it analyzed. The efflorescence was not confined to a single spot. It covered a large part of the surface exposed to the air and was ocular demonstration of the fact that moisture was penetrating though the concrete in quantity sufficient to have some chemical effect on the mortar in the concrete. Analysis of the salts showed, as might be expected, 97 per cent of carbonate of calcium.

This incident recalled to mind comments which, at the request of the publisher of the *Journal of Electricity*, the writer made in 1909 on the first multiple arch dam built in California, in which attention was called to the desirability of making the shell of the cylinder segments thick and dense enough to stop percolation. (*Journal of Electricity*, Dec. 25, 1909.) In line with this suggestion, the following extracts from a preliminary memorandum relating to the design of a proposed dam 200 ft. in height may be of interest, in view of the fact that they would involve a radical departure from what bolder designers have already adopted as standard. (*Journal of Electricity*, June 20, 1914.)

"The aggregate amount of material in the buttresses (except for irregularities in the foundation) is independent of their spacing. The distance between buttress centers may, therefore, be determined with a view to keeping the masonry in the arches at a minimum amount, or to securing specially favorable locations for one or more of the buttresses, or, finally, to keep down their number whereby the cost of preparing the foundation may be reduced. . . . It is believed that the concrete in the arches should have a thickness at least equal to one-twentieth of the depth below water surface. . . . It may be repeated that the perviousness of the concrete will be the principal factor to be considered in this connection and that before reaching final conclusions relating to minimum allowable arch thickness, some experimental data with the particular materials that are to enter into the composition of the concrete may have to be secured. . . . Whether the buttresses should not be spaced further apart than 50 ft. has been given consideration. Wide spacing is desirable, because thereby the number of buttresses is reduced, and the work of excavating for foundations is somewhat simplified. . . . The longer the arch the greater will be the departure from straight line work, which is of importance because straight line work simplifies the closing against bedrock. . . . Giving weight to these considerations, a buttress spacing of 66 ft. between centers has been assumed for a dam 200 ft. high. . . . The upstream face of the arch will cover a span 60 deg. [with a radius of 50 ft.] if the upstream face of the buttresses are made 16 ft. . . . By adopting some such scheme as keeping the upstream buttress face of uniform width from top to bottom, a uniformity of forms will be secured for each unit of the upstream face of the dam, facilitating construction."

Based on an allowable compressive stress of 330 lb. per sq.in., the required thickness of shell was preliminarily indicated as follows:

At the top	2 ft.	At 128 ft.	8.5 ft.
At 32 ft.	2.5 ft.	At 160 ft.	10.5 ft.
At 64 ft.	4.5 ft.	At 192 ft.	12.5 ft.
At 96 ft.	6.5 ft.		

This is in substantial accord with the formula $t = (h \div 20) + 1$, where t is thickness in feet of the shell, and h is depth below the water surface, also in feet. Less thickness, due to the probability of too great permeability, may render the life of a structure and, after a number of years, its safety factor uncertain. In the construction of thin shell dams, there is, in other words, something besides the economical dimensioning to be taken into account. C. E. GRUNSKY.

San Francisco, Calif., Feb. 10, 1928.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Chicago Engineers Discuss Plans for Control of the Mississippi River Floods

About 75 engineers in Chicago attended on Feb. 29 a three-session convocation of the Western Society of Engineers on "Flood Control." Geological structure and history of the Mississippi Valley was covered by Dr. M. M. Leighton, chief, Illinois State Geological Survey, and the economic aspects by W. W. De Berard, associate editor, *Engineering News-Record*. Then followed a symposium on various general phases by John W. Alvord, Daniel W. Mead, Charles B. Burdick and R. H. Ford.

Mr. Alvord stated that this problem, as every other great problem of national import, had its psychological, sociological, economic and physical angles, the first three normally preceding the fourth, in which was the engineering. However, in the case of the Mississippi the physical seems to have outrun the other phases in popular discussion, and this should ultimately give statesmen a good basis for deciding policies.

Mr. Burdick succcinctly put the cost apportionment on the basis of payment in accordance with benefits received, with the whole country as the limit of boundary in a gigantic conservancy district.

Mr. Ford made a wholesale condemnation of the Chief of Engineers' plan, which he called wholly incomplete and inadequate. Instead of 3½ months, he stated, at least as many years are necessary for a proper study of the problem. The Army type of engineer, he held, is not qualified to work out such a plan. He closed with a plea to the engineer to adopt a judicial frame of mind and not to be carried away by the irrelevant, expedient palliations proposed.

Col. Edward H. Schulz spoke on "River Hydraulics and the M.R.C. Solution." Capt. Charles H. West recounted the history of the levee system and emphasized the current radical departure to take in spillways and diversions.

C. R. Knowles, Illinois Central Railroad, in his discussion on the relation of the railroads to flood control, stated that the Jadwin plan would cost the railroads $78,000,000.

"An Analysis of the Proposed Plans for the Flood Protection of the Lower Mississippi Valley" was the subject of a criticism of the Chief of Engineers' report by Daniel W. Mead, though he did commend the chief for his energy in presenting a report within the limited time available. His further views follow: The report must be regarded as a worthy attempt to offer a general plan, which must be supplemented by more extended studies and investigations that may modify some of the tentative conclusions. The basis for changes from the policy followed since 1879 should be established by more thorough investigation than has been possible in the limited time available. The failure of the levee system has not necessarily demonstrated the adequacy of spillways and floodways. Immediate action should involve completion of emergency reconstruction and of such work as will fit in with any complete plan. Further study is needed on maximum flood flow and on economic aspects of the degree of protection required. As to costs, the wide discrepancy between the report of the Chief of Engineers and that of the M.R.C. indicates the lack of information on which to base any complete report. As to administration, the work should be put in the hands of an engineer appointed for the job and not in the hands of a public officer who is subject to retirement. The greatest danger is that through strenuous demand for immediate action the nation may be committed to immatured plans which may present difficulties quite as serious as those which the country now seeks to remedy.

San Francisco to Vote Again on Water System Purchase

May 1 has been tentatively set as the date when San Francisco will vote for the fifth time on a proposed $40,000,000 bond issue for the purchase of the Spring Valley Water Company properties. At all previous elections there has been more than a majority but less than the necessary two-thirds affirmative vote. The properties are wanted primarily because of the distribution system and the reservoirs in and near San Francisco that will be needed when the city's new water supply is brought in by completion of the Hetch Hetchy project. The city has an option on these properties that expires Jan. 1, 1934. Votes at previous elections, held in 1910, 1915, 1921 and 1927, were reported in *Engineering News-Record*, June 23, 1927, p. 1035.

Montreal Typhoid in 1927 Over 5,100 Cases

Typhoid cases reported at Montreal, Que., from March 4, 1927, the official date of the beginning of last year's milk-borne outbreak, to Dec. 31, 1927, totaled 5,115 with 535 deaths. For the entire year there were about 5,135 cases and some 545 deaths. From Jan. 1 to 14, 1928, five cases and one death were reported. The first peak of the epidemic was reached in the fourth week, ended March 31, with 658 cases. The second peak, with 727 cases, was for the eleventh week, ended May 19. It was not until the fifteenth week that the cases fell below 100 (92). After that there was a general decline but they did not fall permanently to 7 or less a week until the thirty-second week, ended Oct. 30. In November and December there were 10 cases in each month, which rate was continued for the first half of January. For periodic statements of cases and deaths, *Engineering News-Record* is indebted to Dr. S. Boucher, director Montreal Department of Health.

Bids Opened on Hudson River Bridge Tower and Anchorage Foundations

Thirty-two bids for the first contract on the Manhattan end of the Hudson River bridge were opened by the Port of New York Authority on March 5. The contract covers the foundations for the Manhattan main tower and anchorage piers. Corresponding contracts were let on the New Jersey side last year and are now well under way. Under the proposal upon which these present bids are based, only that part of the anchorage necessary to permit erection of the steel work is contemplated. Later this steel work will be inclosed in masonry.

The low bid, $986,600, was submitted by the Arthur McMullen Company, New York City. All other bidders were from New York City except H. P. Converse Company, Boston, and the Bates & Rogers Construction Company, Chicago. The list of bids and bidders follows:

Arthur McMullen Co.	$986,600
E. O. Roberts Construction Corp.	1,046,090
Merritt, Chapman & Scott Corp.	1,081,850
Rosenthal Engineering Contracting Co., Inc.	1,115,285
P. T. Cox Contracting Co.	1,135,405
Corson Construction Corp.	1,165,375
Realty Engineering Corp.	1,175,985
Arthur A. Johnson Corp.	1,186,066
Foundation Company	1,195,560
H. P. Converse & Co.	1,202,686
Triest Contracting Corp.	1,211,000
Rosoff Bros.	1,228,575
Cornell Contracting Co.	1,288,000
Wilson & English Construction Corp.	1,297,100
Anthony Cianciulli	1,301,280
Mid-East Construction Corp.	1,310,000
Foley Bros., Inc.	1,320,500
W. H. Gahagan, Inc.	1,354,100
Lyon, Slattery Co., Inc.	1,372,075
Client Construction Co., Inc.	1,386,930
J. F. Murphy Contracting Co., Inc.	1,396,235
Joseph T. Rice	1,421,875
Peter F. Connelly Co.	1,422,950
Bates & Rogers Construction Co.	1,424,250
Del Balso Construction Corp.	1,465,855
Clemente Contracting Co., Inc.	1,493,675
Frederick Snare Corp.	1,510,350
D. C. Serber, Inc.	1,524,675
George Colon Construction Co.	1,556,425
Silas Mason Co., Inc.	1,604,450
T. A. Gillespie Co.	1,612,300
J. F. Cogan Contracting Co.	1,773,425

Edward D. Boyer New President of A.C.I.

The newly elected president of the American Concrete Institute, Edward D. Boyer, is manager of the technical department and cement expert of the Atlas Portland Cement Company, New York City. He is one of the best known and best liked men in the cement field, as is well indicated by his other name, "Uncle Ed."

Mr. Boyer, born in Catasauqua, Pa., studied pharmacy and was graduated from Philadelphia College. Soon, however, he entered the cement field. For twelve years he was secretary and superintendent of the Hercules Portland Cement Company. He designed and constructed the plant of the International Cement Company at Elizabeth, Pa. Thereafter he became connected with the Atlas Portland Cement Company, first at its plant at Northampton, Pa., where he was for ten years, and for the past fifteen years in the executive department of the company at New York.

He has been a director of the American Concrete Institute for many years and has been correspondingly active in the affairs of the organization. His active interest in cement advancement is also displayed in his work in the American Society for Testing Materials. Among his other activities it may be noted that he served as chairman of the committee on concrete ships and barges of the Portland Cement Association, and is a member of the stucco advisory committee of the Bureau of Standards.

"Uncle Ed" is married and is generally recognized as being a desirable citizen.

Queens Borough Sewer Inquiry May Now Proceed

The Court of Appeals of New York State having ruled that a Justice of the State Supreme Court cannot act as an agent of the Governor in investigating charges brought for the removal of Maurice E. Connolly, President of Queens Borough, New York City, for alleged irregularities in connection with large sewer contracts, Governor Smith, on March 2, appointed Clarence J. Shearn, formerly a Justice of the New York State Supreme Court, in place of Justice Townsend Scudder. (See *Engineering News-Record*, Dec. 15, 1927, pp. 978 and 986; Dec. 22, 1927, p. 1021; Dec. 29, 1927, p. 1027, and Jan. 5, 1928, p. 35, for earlier stages of this case, including the names of the leading engineers for the investigation and the defence.) Collection of testimony for use in the prosecution was hindered by a temporary injunction on the grounds that it was illegal to take testimony in private, even as a guide to the procedure in public hearings, and that the Justice appointed to conduct the investigation could not hold two public offices. Emergency legislation was enacted. The decision of the highest court of New York State sanctions the collection of testimony in private but made it necessary to appoint a new investigator.

Engineering Topics Before City Planning Conference

"Mass and Density of Buildings in Relation to Open Space and Traffic Facilities" will be one of several engineering topics discussed at the twentieth National Conference of City Planning, May 7 to 10, at Fort Worth and Dallas, Tex. The discussion will be based on a syllabus prepared by E. P. Goodrich, New York City. Among the other subjects announced are: "Planning Procedure in Smaller Cities," by Jacob L. Crane, Chicago, and Stephen Child, San Francisco; "What Is Comprehensive Zoning?" by Harland Bartholomew, St. Louis; "Developing New Subdivisions," by George H. Herrold, St. Paul; "Airports as a Part of City and Regional Planning," by John Nolen, Cambridge; and "A City Plan Can Reduce Debt and Taxes," by George B. Ford, New York City. The secretary of the conference is Flavell Shurtleff, 130 East 22nd St., New York City.

Port Warehousing Terminal Planned for Halifax

Announcement is made that the Nova Scotia Public Fish & Cold Storage Terminals, Ltd., will build and operate a port warehousing and manufacturing terminal at Halifax. This plant will be along the lines that have proved so successful in Montreal, Philadelphia, New York, Baltimore and other ports of the continent. The expenditure will be about $2,250,000. A site has been selected and it is planned to commence work soon.

Bill Provides for Measuring River Discharge and Mapping

Topographic mapping and measurement of river discharge as contributing to a solution of the Mississippi River flood problems are provided for in House bill 11142 introduced by Congressman Temple, of Pennsylvania. This is the first bill looking to immediate action on the collection of these data.

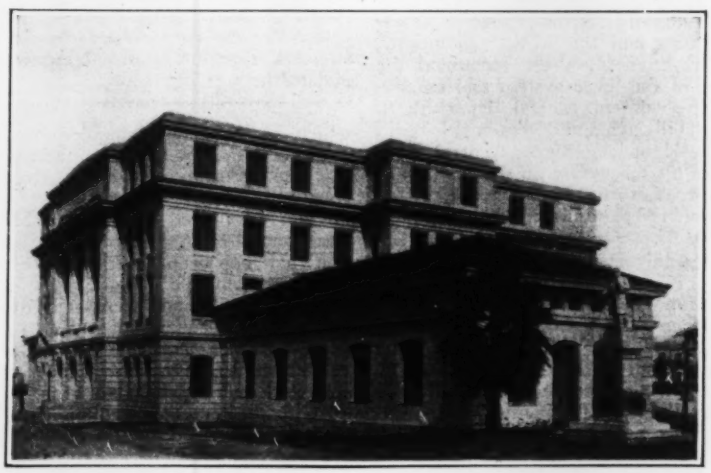
The bill authorizes the Secretary of the Interior through the agency of the Geological Survey "to make a topographic survey of the entire area of the alluvial valley of the Mississippi River from Cape Giradeau, Missouri, to the Gulf of Mexico and of such other areas on tributary streams, and to collect such records of river discharge as may be required for the investigation and solution of flood problems in the Mississippi River Basin." An appropriation of $2,800,000 is provided by the bill.

Los Angeles County Sewer System Placed in Operation

Sewage has been turned into the recently completed portion of the extensive system of trunk sewers being built by the County Sanitation Districts of Los Angeles County, Calif., and pending the construction of the ocean outfall the sewage is being treated by an activated-sludge process. (See *Engineering News-Record*, June 18, 1925, p. 1026, for description of the entire project, which as then planned included 170 miles of trunk sewers.)

The activated-sludge plant thus far built has a nominal capacity of 3 m.g.d. It is so arranged that it may be extended as the flow increases and also may be converted into a sedimentation plant when the ocean outfall is ready. Before going to the activation tanks, the sewage passes through longitudinal presedimentation tanks from which the sludge is to be removed by Link-Belt sweeps. Compressed air is admitted to the activation tanks through perforated pipes located at one side so as to give

HAVANA, CUBA—THE RECENTLY COMPLETED ENGINEERING SCHOOL, UNIVERSITY OF HAVANA



spiral flow. The final settling tanks are equipped with Dorr sludge sweepers. Contracts have recently been let for additional final settling tanks, which are to be equipped with a Hardinge spiral sludge-removing mechanism. A. K. Warren is chief engineer of the Los Angeles County Sanitation Districts.

World Congress of Engineers Committee Announced

Secretary Hoover, as honorary chairman, has announced the appointment of 78 of the nation's most prominent engineers and scientists on the American Committee of the World Congress of Engineers, to be held in Tokio in November, 1929. The permanent American committee will promote the aims and purposes of the movement and arrange for attendance of American engineers at the congress.

Promotion of international co-operation in the study of engineering science and problems in all its branches, and stimulation of a sense of brotherhood among engineers of the world are the announced purposes of the congress, which will be the first one ever held, as set forth by Baron K. Furuichi, president of the Engineering Society of Japan. The entire enterprise is under the sponsorship of the Japanese government.

Among well-known members of the American committee are Thomas A. Edison, John Hays Hammond, Samuel Insull, William B. Mayo, of the Ford Motor Company; Charles M. Schwab, Gerard Swope, president of the General Electrice Company; Samuel M. Vauclain, president of the Baldwin Locomotive Works; Daniel Willard, president of the Baltimore & Ohio Railroad; Orville Wright, Gen. William Barclay Parsons, James H. McGraw, of the McGraw-Hill Publishing Company, Inc.; H. H. Westinghouse, of the Westinghouse Air Brake Company; Alfred Sloan, Jr., President of the General Motors Corporation; Michael I. Pupin, of Columbia University, and William Green, president of the American Federation of Labor.

Two-Day Meeting on Problems of Sewage-Works Men

A departure from the usual program at this year's annual meeting of the New Jersey Sewage Works Association will be a two-day instead of a one-day session, but the meeting will be held at Trenton as usual. The time is March 23 and 24. Speakers from outside the state will be John F. Skinner, deputy city engineer, Rochester, N. Y., and Wellington Donaldson, of Fuller & McClintock, New York City. Their respective topics will be "The Value of Improving the Appearance of Disposal Works" and "Initial Operation of Imhoff Tanks at New Castle, Pa." Four papers on odor control are scheduled, including one by W. J. O'Connell, Jr., Fellow, the Chlorine Institute, New Jersey Sewage Experiment Station, New Brunswick. On Friday evening, March 23, there will be a conference of chemists on biological oxygen demand problems. The Saturday morning session will be devoted to various aspects of local sewage-works.

Railway Bridge Is Proposed Over the St. Lawrence

Application has been made to the Canadian Parliament for permission to incorporate the St. Lawrence River Bridge Company, with power to construct an international bridge spanning the St. Lawrence River in the neighborhood of Brockville, Ont. The southern terminus of the bridge would be about 4 miles west of Morristown, N. Y. Among other powers the proposed charter would give the company the right to build and operate a railway about 20 miles long in order that the bridge might be connected with existing rail services. The capital of the company is set at $3,000,000, with power to raise $15,000,000 additional by the issue of bonds. Those applying for incorporation are G. P. Graham and J. Gill Gardener, Brockville; W. A. McLean, Toronto; George P. Murphy, Ottawa, and Ward C. Pitfield, Montreal.

Eminent Dutch Engineer to Talk in U. S. on Flood Control

Under the auspices of the Institute of International Education, Dr. Cornelis Lely, president and honorary member of the Netherlands Royal Institute of Engineers and member of the Royal Academy of Sciences, is visiting the United States and will give addresses in the leading universities on "Development of the Zuider Zee and Flood Control." This work, which is now under way, involves the building of dikes and the reclamation of more than 550,000 acres of land.

On March 6 Dr. Lely was guest at a luncheon given in New York City by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. John R. Freeman, consulting hydraulic engineer, presided.

Dr. Lely was born in Amsterdam, Holland, and was graduated as a civil engineer from Delft Technical University. His career has been a succession of notable services. He spent a term as governor of the Colony of Surinam and served as alderman for public works of the city of The Hague, as president of the Zuider Zee board and of numerous state commissions. He was appointed by the Zuider Zee Association to study the problem of the drainage of the Zuider Zee and his plan, sanctioned by the Netherlands Parliament, is now being carried out. Dr. Lely is also a member of the Commission consultive internationale du Canal maritime de Suez and is president-curator of Delft University. He has published several works on hydraulics.

Settlement Financing Proposed for Reclamation

A bill providing for improved settlement methods for federal reclamation projects in the West has just been introduced in Congress. Its general purpose is similar to that of the Kendrick bill of two years ago, though many details differ. The bill would authorize the Bureau of Reclamation of the Interior Department to do the necessary construction and preparatory work to convert raw desert land into a state of readiness for farming, instead of (as at present) limiting the bureau's work to providing irrigation canals. Farms to be laid out under this provision of the law are to be limited to a maximum size of 160 acres, and farm workers' units are limited to ten acres. Loans for development of a farm may be made up to a maximum of $3,000 but not exceeding 80 per cent of the value of the improvements, the loan to be secured by first mortgage

NEW YORK CITY—WOOD-BLOCK PAVEMENT, RIVERSIDE DRIVE VIADUCT, BUCKLED BY FREEZING WATER

and to be repaid with 4 per cent interest in semi-annual installments within 28 years. Similar loans on farm workers' units may be made up to $1,000. The improvement work, such as leveling, clearing, building construction and the like, may be done by the bureau, but 20 per cent of its cost must first be paid by the settlers.

In order to safeguard such loans, it is provided that the government may require that land owners and settlers shall cultivate the land in approved manner and keep it in good order until all advances are fully paid, and that in case of any default, it may foreclose on the land. An appropriation of $500,000 from the Reclamation Fund is authorized for the purposes of the act.

Chicago Has Big Bridge Work for 1928

Five bascule bridges under construction and a sixth authorized form the main part of the bridge program at Chicago for this year's work. The substructure of the Roosevelt Road bridge over the proposed new channel of the Chicago River is practically completed and steel erection is about to commence. For the Taylor St. bridge over this channel, the substructure is under way and the contract for superstructure will be let during the year. The LaSalle St. bridge over the main river has the substructure completed and the south leaf erected, and work is in progress on the north leaf and north viaduct approach. The substructure for the Clark St. bridge is under way and the contract is let for the superstructure. Funds for the Wabash Ave. bridge are provided in the 1928 appropriation, but no definite time is set for starting the work. For the 106th St. bridge over the Calumet River, the substructure is under construction and the contract for superstructure has been awarded. A temporary pontoon bridge over the Calumet River at 130th St. will be built if the condition of street construction warrants it. All this work is under the direction of Loran D. Gayton, city engineer, and Thomas G. Pihlfeldt, engineer of bridges.

With the completion of these bridges the existing bond issues for bridge construction will be practically exhausted and no definite program for future bridges has been prepared.

California Registration Law to Be Discussed

The Los Angeles Chapter, American Association of Engineers, has planned a conference to be held on March 10, 1928, at the Western Road and Equipment Exposition in Los Angeles, to enlist support of the engineers in favor of the enactment of a registration law for engineers in California. Announcements urging the attendance of all engineers in California and the West have been sent out by the association. March 10, has been designated as engineers day at the exposition.

Washington Notes

Flood-Control Bill Favorably Reported to Senate—Federal Aid Highways—Toll Bridges

By Paul Wooton
Washington Correspondent

THE commerce committee of the Senate has agreed on a flood-control bill which was reported to the Senate March 2, with an urgent recommendation that it be passed. The legislation is based on the Jadwin plan, but sets up a board, to consist of the Chief of Engineers, the president of the Mississippi River Commission and a civilian engineer, which is to decide controversial points in the engineering plan. The civilian member of the board is to be appointed by the President, who also is given full authority to fix the amount of his salary. It is the intention of the committee that the best available man for the place be secured regardless of salary limitation.

The bill authorizes an appropriation of $325,000,000 and recognizes the principle of local contribution by requiring the local interests to pay one-third of the cost to bring the entire levee line up to the grade and cross-section prescribed for 1914. This will involve an expenditure on their part of $15,000,000. In addition, rights-of-way for main levees are to be furnished without cost to the federal government. The local interests are relieved of further participation in view of their expenditure of $292,000,000 in the past for flood control. The bill contemplates payment by the federal government for easements or rights-of-way for floodways. Under the bill the Mississippi River Commission loses its status as a semi-independent agency and is placed under the direction of the Secretary of War and the supervision of the Chief of Engineers. The project is confined to the main stem of the Mississippi River from Cape Girardeau to the Gulf, but includes the tributaries to the extent that they are affected by the flood waters of the Mississippi. While the bill expresses the sense of Congress that surveys of the tributaries should be prosecuted speedily, it does not satisfy the tributary interests. A determined effort will be made to amend the bill to broaden its scope.

Federal Aid Highways

The Senate, on March 2, passed the Oddie bill, authorizing the continuance for two years of the federal aid highway program. The government is to contribute at the rate of $75,000,000 yearly. Provision is made in addition for forest roads and trails. The Senate approved an amendment by Senator Reed, of Pennsylvania, making a portion of the fund applicable for use in planting trees and beautifying highways. This amendment is opposed by the state highway commissions. Their position is that all money should be concentrated on road construction at this stage of highway development. The Senate also approved the provision allowing automobile organizations that have been putting up highway markers to continue to do so under state supervision.

Representative Burtness, North Dakota, has introduced a bill which was understood to have the approval of the House committee, which will allow the use of considerable additional amounts of federal aid on roads in the outskirts of towns and on bridges in the same area. The present law provides that federal aid may be used in towns of more than 2,500 population for a distance of one mile from the city limits where the houses average more than 200 ft. apart. The bureau of public roads has interpreted this law as referring to fractions of a mile, but a departmental ruling some months ago held that the conditions set up by the law must apply over a full mile. As a result a number of projects have been held up, particularly those involving bridge construction. Under the Burtness bill the practice previously followed would be made lawful.

A New Toll Bridge Bill

Introduction by Representative Denison, of Illinois, of a toll bridge bill has revived the discussion of this matter in Congress. Representative Cochran, of Missouri, admits that the Denison bill is an improvement over the existing law, but he condemns it because it affords no protection to the purchasers of the securities issued prior to the construction of the bridge. In a speech on the floor of the House March 1, he declared that "unless the Congress takes some position the people of the country will be in the clutches of a toll bridge trust. Congress, in some way, should demand that before the plans and specifications are approved a limitation be placed on securities issued in keeping with the actual cost of construction and financing."

More Politics and Engineering at Baltimore

Herbert J. Leimbach has been temporarily appointed supervising engineer of the Public Improvement Commission, Baltimore, Md., to succeed Henry G. Perring, resigned. The appointment is for 30 days, pending an examination of candidates for the position by the Civil Service Commission. Mr. Perring and Charles F. Goob, chief engineer of Baltimore and a member of the Public Improvement Commission, have been appointed a committee to confer with the Civil Service Commission or its secretary "and prepare specifications for the position," in place of those already existing. The action was taken after a controversy in the meeting of the Public Improvement Commission which finally resulted in the deposition of its chairman and secretary, so far as supervision over the temporary appointee is concerned. Mayor Broening, ex-Mayor Mahool and Mr. Goob outvoted their opponents.

Personal Notes

P. K. SCHUYLER has recently resigned as associate highway bridge engineer with the Bureau of Public Roads, Washington, D. C., and has accepted the position of chief engineer with the Ingalls Corporation, of 57 William St., New York City. The Ingalls Corporation is associated with the banking house of P. W. Chapman & Company, Inc., and is engaged in constructing and financing numerous toll bridge projects.

J. R. WEST, whose return to this country from China was announced in this column last fall, has been appointed chief engineer of the Port of Seattle, Wash. Mr. West thus returns to the position he left eleven years ago to take up engineering work in the Orient.

A. S. LANGSDORF has been appointed dean of the schools of engineering and architecture at Washington University, St. Louis, Mo., to succeed W. E. McCourt, appointed assistant chancellor.

O. W. HANSEN has been appointed engineer of bridge maintenance in the bureau of engineering, department of public works, Chicago, to succeed the late F. H. Avery.

J. J. HILLS has been appointed superintendent of the Miles Ferry bridge, at Vonone, Tenn., which is being constructed by the Southern Construction Company, Birmingham, Ala., as contractor. Mr. Hills' last job was on a concrete arch bridge at Galena, Mo., and prior to that he was employed on the Mendota-Fort Snelling bridge during its entire construction.

MAURICE R. SCHARFF, formerly chief engineer of the Philadelphia Company and of the Pittsburgh branch of the Byllesby Engineering and Management Corporation, has opened offices in Pittsburgh, Philadelphia and New York as a consulting engineer in association with Main & Company, certified public accountants. He will give special attention to consultation and reports relative to public utility engineering and construction, public utility valuation and rates and other engineering-accounting and engineering-legal problems.

T. C. MCEWEN, of Jackson, has been appointed chief engineer and O. F. GOETZ assistant engineer of the Tennessee State Highway Department. Mr. McEwen is a graduate of the engineering school of the University of Tennessee, and since 1921 has been in charge of highway construction in 26 counties in the western division of the state. Mr. Goetz is a graduate of the engineering school of the University of Tennessee, and also took special work at Columbia University. For two years prior to his connection with the State Highway Department Mr. Goetz was connected with Knox County in road construction.

COL. JAMES A. WOODRUFF, Corps of Engineers, district engineer of the Second New York and Porto Rico Engineer Districts, with headquarters at 39 Whitehall St., New York City, has recently been appointed district engineer of the Philadelphia Engineer District in addition to his other duties.

ALEX MAIN and RALPH A. MAIN, respectively city engineer for more than 30 years and assistant engineer for more than three years in the engineering department of Ellwood City, Pa., have opened an office in that city under the name of Alex Main & Son, engineers. They will specialize in municipal engineering, sewage disposal, water supply, estimates and land surveying.

W. C. BICKFORD, an engineer of Seattle, Wash., has been re-elected president of the Seattle Construction Council, an organiation of 200 subcontractors and building material dealers, affiliated with the Seattle Chapter, Associated General Contractors of America.

Engineering Societies

Calendar

Annual Meetings

BUILDING OFFICIALS CONFERENCE OF AMERICA, Springfield, Mass.; Annual Meeting, Detroit, Mich., April 24-27.

AMERICAN WELDING SOCIETY, NEW YORK; Annual Meeting, New York, April 25-27.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, May 7-10.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, El Paso, Tex., June 4, 5 and 6.

AMERICAN WATER WORKS ASSOCIATION, New York; Annual Convention, San Francisco, week of June 11.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION; Annual Meeting, University of North Carolina, June 25.

THE BALTIMORE SECTION, American Society of Civil Engineers, held a meeting March 2. Major Dan I. Sultan, Corps of Engineers, U. S. A., gave an address outlining the scheme proposed by the Corps of Engineers for Mississippi River flood control. Resolutions were unanimously adopted indorsing H.R. 11026, "Bill to Provide for the Reorganization of the Public Health Activities of the Government and for Other Purposes," and H.R. 8111, "Bill to Provide for an Inventory of the Water Resources of the United States."

THE SAN FRANCISCO SECTION, American Society of Civil Engineers, held the regular bi-monthly meeting on Feb. 24. Following a ten-minute talk by Earl R. Huber, junior member, on "Mountain Surveying Experiences," the technical program, consisting of three main subjects, was taken up. The papers presented were as follows: "Arrangement and Operation of Large Icing Plants," by H. T. Whyte, assistant general manager, Pacific Fruit Express, San Francisco; "Design and Construction of Roseville Icing Plant," by Louis I. Denton, mechanical engineer, Pacific Fruit Express, San Francisco; and "Terminal Freight Train Operation," by Carl Maughmer, Assoc. M.Am.Soc.C.E., assistant engineer, Sacramento Division, Southern Pacific Company.

THE ROCKY MOUNTAIN SECTION of the American Water Works Association has elected officers as follows: Chairman, P. E. Strouse, Rocky Ford; vice-chairman, Chester Truman, Roswell; secretary-treasurer, Dana E. Kepner, sanitary engineer, Colorado State Board of Health.

THE NEW ENGLAND WATER WORKS ASSOCIATION will hold its March meeting in the Boston City Club on March 14. The meeting will be devoted to the presentation and discussion of the report and proposed resolutions of the committee on cross-connections.

THE AFFILIATED TECHNICAL SOCIETIES OF BOSTON will give a luncheon on March 12 at the Boston City Club at which Gov. Alvan T. Fuller will be the principal speaker.

THE ILLINOIS SECTION of the American Water Works Association will hold its twentieth annual meeting at the University of Illinois, Urbana, Ill., on March 29 and 30.

Obituary

J. L. BOYLE, formerly a partner in the Thompson & Boyle Company, later succeeded by the Western Pipe & Steel Company, died in Los Angeles on Feb. 23, aged 61.

F. A. HIBBARD, of Sherbrooke, Que., died on Feb. 28, aged 64 years. Mr. Hibbard was born in Montreal and was engaged upon railway construction nearly all his active life. His first important appointment was during 1881-85, when he was locating engineer and superintendent of construction on the Canada Atlantic Railway, now part of the Canadian National Railway. Upon completion of this work he held several responsible positions in connection with railway building in eastern Canada and the United States. For some years he was assistant engineer for the National Transcontinental Railway, but was compelled to retire on account of failing health.

HENRY ROOT, 83 years old, pioneer railroad builder, died in Oakland, Calif., on Feb. 23. He was engineer in the construction of the old Central Pacific and chief engineer of the California Street Cable Company. He retired from active work some years ago.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Brick Manufacturers Appoint Highway Committee

A committee of highway engineers has accepted an appointment by the National Paving Brick Manufacturers Association to make a study of all types of road and street pavements and to embody its findings in a report which is to be made public when completed. The committee is composed of William H. Connell, chairman, formerly engineering executive of the Pennsylvania State Highway Department and now engaged in general engineering and consulting practice; Warren R. Neel, state highway engineer of Georgia; Perry J. Freeman, chief engineer of the Bureau of Specifications and Tests of Allegheny County, Department of Public Works, Pittsburgh; and Frederick J. Cellarius, consulting engineer and formerly city engineer, Dayton, Ohio. According to F. L. Manning, president of the National Paving Brick Manufacturers Association, the committee has been authorized to proceed with such surveys, tests and investigations on highway construction as will result in codifying existing knowledge and be of benefit both to road users and to road builders.

Concrete Road Yardage

For January the square yardage included in concrete pavement contract awards, according to the Portland Cement Association, was 4,102,847 for roads; 1,711,976 for streets; and 87,207 for alleys; or a total for the month of 5,902,030 sq.yd.

Business Notes

SCHRAMM, INC., West Chester, Pa., announces the opening of new branch offices at Tulsa, Okla., San Francisco, Calif., and Boston, Mass.

INDIANA TRUCK CO., Marion, Ind., has been merged with the Brockway Motor Truck Corporation, New York City. The new company will retain the name of the Brockway Motor Truck Corporation, with combined assets of $9,000,000. Based on sales in excess of $15,000,000 last year for the two companies, the new combination will be one of the three largest corporations in the United States exclusively engaged in the manufacture of motor trucks, according to George A. Brockway, president. Both lines of Brockway and Indiana trucks from 1 to 7.5 tons capacity will continue in production. All of the 38 direct factory branches of the two companies will be maintained in operation.

BLACK & DECKER MFG. COMPANY, Towson, Md., announces that R. C. Bastress will handle the company's sales in Indiana and part of Michigan, that L. W. Beuhasen will be in charge in western Massachusetts, and that G. N. McCarthy will represent the company in the Buffalo, N. Y., territory.

ARMCO CULVERT MFRS. ASSOCIATION, Middletown, Ohio, announces that Harry E. Cotton, formerly assistant city engineer, Omaha, Neb., has been appointed municipal engineer for the association. Mr. Cotton has had 19 years' experience in municipal work, and his new position will place him at the service of all municipalities in the United States and Canada for assistance in the solution of problems involving drainage, subdrainage, and flood control.

WESTINGHOUSE ELECTRIC & MFG. COMPANY has recently received an order from the Illinois Pipe Line Company for 18 400-hp., 1,800-r.p.m. synchronous motors with magnetic control with pressure-gage regulators. These motors are to be used to drive A. S. Cameron centrifugal pumps in the company's oil pipe lines between Rankin, Texas, and Del Rio, Texas. The equipment duplicates ten units recently installed in five booster stations on the company's line in Ohio.

UNITED STATES GYPSUM COMPANY, Chicago, announces that it has sold the last of the retail businesses acquired by it in 1921 when it purchased J. B. King & Company. The business sold was the Windsor Cement Company, Boston.

PARADON MANUFACTURING COMPANY, Arlington, N. J., announces the appointment of W. D. Case c/o Graver Corporation, 411 Mutual Building, Kansas City, Mo., as its sale and service representative in Kansas, western Missouri, Nebraska, Arkansas and southwestern Iowa.

CLIMAX ENGINEERING CO., Clinton, Iowa, announces the appointment of the Equitable Equipment Co., 410 Camp St., New Orleans, La., as the sales and service representative for the territory of lower Louisiana and Mississippi.

ALLIS-CHALMERS MFG. CO., Milwaukee, has opened a district sales office at Phoenix, Ariz., covering the states of Arizona and New Mexico, and the northern part of the Republic of Mexico. The office is in charge of J. B. Cooper. Branch offices have also been opened at San Antonio, Texas, and Grand Rapids, Mich., with Earl R. Hury and G. C. Culver, respectively, in charge.

CAL DIVISION, NORTH AMERICAN CEMENT CORPORATION, will move its headquarters on March 1 from Hagerstown, Md., to the general sales offices of the corporation at New York City. Richard H. Catlett, manager of the Cal Division, will be transferred to New York in his present capacity.

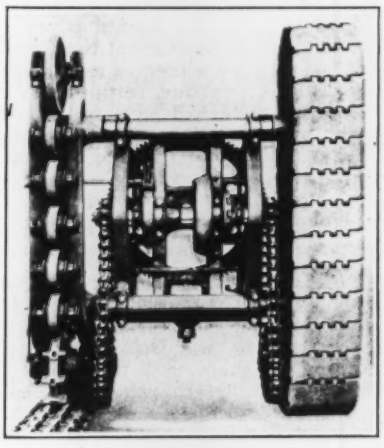
KALMAN STEEL COMPANY, Chicago, has recently purchased the plant and equipment of the Sykes Metal Lath Company, Niles, Ohio. The Sykes organization will be consolidated with that of the Kalman Steel Company in the distribution of a complete line of metal lath and building specialties.

DOMINION STEEL CORPORATION, LTD., which controls various subsidiary companies embraced in the British Empire Steel Company, has recently been purchased by Wood, Gundy & Company, a financial house of Toronto.

New Developments

Single-Shaft Drive Crawler Is Important New Design

An important new development in excavating machinery is the single-shaft drive crawler-type mounting being furnished for the Gas + Air and the Model B-2 power shovels and cranes manufactured by the Bucyrus-Erie Co., South Milwaukee, Wis. The design is said to have resulted from a desire to

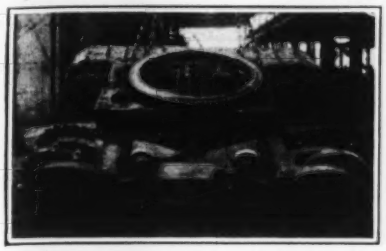


place the crawler tread mounting in a simple and yet entirely reliable form.

This new mounting has fewer parts and hence extra strength can be built into it with no added weight. It is claimed to be non-clogging to the highest degree. Even when the crawler is full of dirt it is said to throw out all the

material as it moves ahead its own length. The drive chains, too, are self-cleaning. Grades up to 30 per cent can be negotiated and right angle turns or long radius turns made with the mounting.

Complete accessibility for renewing or inspecting parts is another feature of the mounting. The one necessary gear and its pinion are inclosed and operate with



a clearance of 12 in. above the ground. The drive shaft is splined, no keys being used. The truck frame is a one-piece annealed steel casting 23 in. deep. The accompanying illustrations show both the top and under side of the new mounting.

Filter Floor System for Trickling Filters

A new filter floor system recently installed in trickling filters in a number of Ohio cities including Cleveland, Akron, Delaware, and Fostoria, has been patented and placed on the market by the

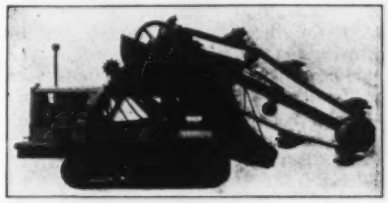
Metropolitan Paving Brick Company, Canton, Ohio. The Metro floor system of vitrified clay consists of channel blocks over the top of which grill sections are fitted as shown in the accompanying illustration. A special feature of the system is that the entire filter floor is available as a drainage and aerating area. Other features include the facts that the system is easily cleaned, insures proper ventilation at all times, and is so designed as to give sufficient velocity to carry off the fine sediment and sloughed solids. Ample provisions are made for flushing. The manufacturers especially point out the ease and economy of construction, involving only the setting of the channels in a mortar bed and the filling of the joints with cement grout.

New Lubricator for Vertical Shaft Centrifugal Pumps

Designed to supply oil to bearings of vertical shaft centrifugal pumps only when the pump is running, a new lubricator is being offered by Yeomans Brothers Company, Chicago, to accomplish the following results: (1) Stop needless waste of oil; (2) lessen danger of bearings running without oil; (3) lessen frequency of filling oil container; (4) cut down maintenance and repairs; (5) increase reliability. Such a lubricator is claimed to be especially advantageous on such equipment as centrifugal pumps which invariably run intermittently. With the ordinary sight feed lubricator, much oil is wasted while the pump is idle. The Yeomans lubricator, known as an oil economizer, has a liberal capacity with individual adjustable sight feeds for all guide and thrust bearings requiring gravity lubrication. The needle valve in the oil container is automatically opened and closed by a diaphragm mounted on top of the lubricator and connected by copper tubing and piping to the pump discharge.

Small Ladder Type Ditcher for Shallow Trench Work

A new ditcher has recently been developed by the Austin Machinery Corporation, Muskegon, Mich., known as the "Little Wonder" Public Service ditcher and designed for digging shallow trenches for sewers, water pipe, electric conduit and similar installations. The important features include a positive crowding of the boom while digging, a worm and gear hoist which locks the boom in any desired position, two digging speeds on the excavator chain, two speeds on the conveyor belt, and a



compact design. The machine is designed to dig 9 inches from obstructions. Its digging widths range from 16 to 30 in. and its depths from 4 ft. to 8 ft. The overall length of the machine without the boom is 15 ft. and the overall width 7 ft. The feed transmission is by cut gears operating in an oil tight housing, providing three forward and three reverse speeds. The machine is crawler mounted. The boom is of 8-in. steel channels carrying cast steel buckets with lips and bucket hangers cast integral. Lubrication is by the Alemite high pressure system.

Manufacturers and Trade Associations

Calendar

Annual Meetings

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; Annual meeting, Biloxi, Miss., March 19-21.

SOUTHERN PINE ASSOCIATION, New Orleans; Annual meeting, New York City, March 26-28.

AMERICAN WATERWORKS MFGRS. ASSOCIATION, New York City; Annual meeting, San Francisco, Calif., June 11-14.

New Publications

Floor Reinforcement — NATIONAL STEEL FABRIC COMPANY, Pittsburgh, Pa., has published a folder containing four pamphlets of information on its Steeltex for floors, which is a combined reinforcing and form purchased in rolls ready for application. The main booklet is a general treatment of the subject, including photographs and descriptions of the material, tables of safe loads and other data. The three other pamphlets are data sheets considering respectively the use of Steeltex on (1) steel joists with round top chords, (2) steel joists with flat flanges, and (3) wood joists.

A Quarter Century of Bridge Foundations—FOUNDATION COMPANY, New York City, has recently published a booklet in which it pictorially presents some of its accomplishments in placing bridge piers in the United States and Canada during the past 25 years. A number of old prints of foundation work in the seventeenth and eighteenth centuries are also included.

Industrial Cranes — WHITING CORPORATION, Harvey, Ill., has issued its new crane catalog No. 209 containing 68 pages devoted to its line of cranes, describing overhead cranes for railways and power houses, and general industrial plant installations, including overhead cranes, gantry cranes, hand power traveling cranes, jib cranes, pillar cranes and wall and bracket cranes. Many illustrations are given of the company's large overhead electric cranes, and lists of the users are included. The booklet contains complete specifications with regard to capacities and sizes.

Gas-Welding Equipment — TORCHWELD EQUIPMENT COMPANY, Chicago, has recently published a 36-page booklet describing its various types of equipment for gas welding and cutting. Accessory equipment such as gas pressure regulators, acetylene generators, goggles, gloves, wrenches, etc., is included.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Steel Market Firm; Lumber Firmer

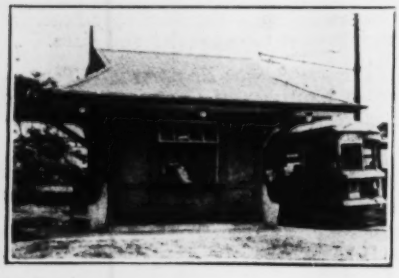
Active demand by the automotive, railroad and construction industries is maintaining the $1.90 rate announced last week for structural steel. It is recognized, however, that this is not a time for stiffening prices without due regard to the traffic. Demand from certain important steel consumers, such as the oil industry, is below average. In fact, it is quite likely that considerable tonnage will be shipped at $1.85 per 100 lb.

Lumber demand is 14 per cent greater than current output, with shipments only 1 per cent above output, indicating that reserves are being reduced. The effect is firmer prices for large-sized timbers, and advances of $1 and $3.50 per M. for wood lath and spruce 2x4s, respectively. Pine flooring, on the other hand, has dropped $5 in the principal markets. The number of active pine sawmills in the Pacific Northwest has not been increased in the last week, and there are many unemployed men. Bad weather in the Douglas fir district has hampered operations but has not caused shutdowns. In the Southern pine belt, demand is 1.24 per cent and shipments 1.76 per cent under production. Of 106 mills in this region, 73 are on full time, with nine of these working overtime.

Brick shipments into the New York district by rail during the last week numbered 193 cars, against 207 in the preceding week. Water shipments amounted to six barges, with twelve for the week before. Volume of wholesale brick buying dropped 20 per cent in the last week, without affecting delivered prices in Manhattan.

$1,000 Erects Attractive Station at Little Rock

Arkansas Power & Light Co. has built a combination waiting-room and news-stand at the end of the Rock Island street car line at Little Rock, Ark. The station, shown in the illustration, is of stucco and frame, 6 x 12 ft. by 15 ft. high, on a concrete base. Cost was approximately $1,000.



This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended March 8, with some comparisons, total as follows:

(In Thousands of Dollars, 000 Omitted)

Week Ended	Public	Private	Total
Mar. 8, 1928	**$13,967**	**$39,403**	**$53,370**
Mar. 1, 1928	16,968	82,549	99,517
Mar. 10, 1927	27,407	54,796	82,203
Jan. 1 to date:			
1928	166,788	397,373	564,161
1927	150,213	337,529	487,742

E. N.-R. Index Numbers

Cost		Volume	
Mar. 1, 1928	**204.65**	**February, 1928**	**225**
Feb. 1, 1928	204.65	January, 1928	208
Mar. 1, 1927	208.80	February, 1927	182
Average, 1927	206.24	Average, 1927	263
Average, 1926	208.03	Average, 1926	228
1913	100.00	1913	108

Heavy Bond Offerings—Highest Week Since October

Bond offerings of $263,246,000 for the week ended March 2, 1928, represent the largest week's volume of financing since the week of Oct. 21, 1927. Excluding a $100,000,000 railroad refunding issue this is 53 per cent greater than the preceding week and 67 per cent higher than the total for the corresponding period last year, according to *Wall Street Journal* figures.

The largest single railroad bond issue in several years was the $100,000,000 St. Louis-San Francisco 4½s offered last week. Two other outstanding issues of the week were the $52,000,000 rapid transit 4s offered by New York City and $41,101,000 Province of Buenos Aires 6s. These three issues constituted 73 per cent of the week's total.

Railroad, municipal and foreign bonds were the three leading groups in the offerings last week; the preceding week public utility and railroad bonds were in the lead. The largest public utility offering was $20,000,000 National Public Service Corporation 5s. Offerings for the last two weeks by classes are as follows:

	Feb. 24	March 2
Railroad	$21,800,000	$100,000,000
Public utility	49,550,000	18,950,000
Industrial	15,500,000	22,700,000
Municipal	8,450,000	58,500,000
Foreign	10,000,000	48,850,000
Real estate	1,400,000	11,250,000
Miscellaneous	.....	3,000,000
Total	$106,700,000	$263,250,000

Chicago plans to expend $46,206,000, proceeds of bond issues, to complete street widenings and $9,000,000 for new street projects. The estimated grand total of requirements reaches $76,206,000, including $4,000,000 for new fire stations and $17,000,000 for new street, traffic, police and fire signal lights. This new financing will be voted on in April.

The following table includes some of the more important bonds offered in the last two weeks:

RECENT IMPORTANT BOND OFFERINGS

	Amount	Interest Rate and Yield
Public:		
New York City (Corp. Stock)	$52,000,000	4 3.70
Jersey City	3,650,000	3 3.97
San Francisco	2,500,000	3.85 4½ 4.00
Minneapolis	1,350,000	4 3.80
Hidalgo Co., Texas (road)	1,300,000	5½ 4.90–5
New Haven	1,245,000	4 3.75
Jacksonville	800,000	5 4.05
Johnston Co., N. C. (school)	750,000	4½ 4.15–.20
Montgomery Co., Ohio (road)	700,000	4½ 3.9 –4.0
Hartford Co., School Dist., Hartford, Conn	600,000	4 3.80–.85
Rye, N. Y.	570,000	4 3.70–.90
Orangeburg Co., S. C. (highway)	550,000	4½ 4.20
Scarsdale Union Free School District	400,000	4½ 3.80–.90
Public Utility:		
National Public Service Corp.	20,000,000	5 5.35
Scranton Gas & Water Co., 1st	11,000,000	4½ 4.56
Birmingham Electric Co.	9,200,000	4½ 4.77
Rochester Gas & Elect. Corp.	6,000,000	4½ 4.52
Oklahoma Power & Water Co.	4,500,000	5 5.30
Inland Gas Corp., 1st sinking fund	4,400,000	6½ 6½
Inland Gas Corp., sinking fund deb.	1,500,000	7 7
Lackawanna & Wyoming Valley R.R. Co.	2,900,000	5 5.20
Associated Tel. Utilities Co.	2,000,000	5 5
Lackawanna & Wyoming Valley R.R. Co.	1,100,000	6 6
New England Water, Light & Power Assoc.	1,450,000	5½ 5½
Railroad:		
St. Louis-San Francisco Ry. Co.	100,000,000	4½ 4.65
Nashville, Chattanooga & St. Louis Railway	16,800,000	4 4.14
Central Vermont Railway Co.	5,000,000	4½ .....
Industrial:		
Certainteed Products Corp.	13,500,000	5½ 5½
Firestone Cotton Mills	12,000,000	5 5.25
Kraft-Phenix Cheese Co.	5,000,000	4½–5 4½–5.35
U. S. Radiator Corp.	3,500,000	5 5.20
Troy Laundry Machine Co., Inc	3,000,000	6½ 6½
Foreign:		
Province of Buenos Aires	41,101,000	6 6½
Rhine-Ruhr Water Service Union	10,000,000	6 6.55
Oslo Gas & Electric Works	6,000,000	5 5.30

If interested in unit prices on buildings, turn to the Unit Prices section of this issue.